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Oviposition of Psorophora Columbiae (Dyar and Knab) in Louisiana Pastureland.

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OVIPOSITION OF PSOROPHORA COLUMBIAE (DYAR AND KNAB) IN LOUISIANA PASTURELAND

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OVIPOSITION OF *PSOROPHORA COLUMBIAE* (DYAR AND KNAB) IN LOUISIANA PASTURELAND

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Entomology

by
Dwight Charles Williams
B.S., University of Arkansas, 1977
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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

ABSTRACT

Cattle hoofprint samples from a permanent pasture in Vermilion Parish, Louisiana during 1980 yielded an average of 9.2 eggs and capsules of Psorophora columbiae (Dyar and Knab)/hoofprint. Pasture sections differed significantly ($P<.0001$) in number of eggs and capsules/hoofprint. Sections ranged from 2.7 to 20.6 eggs and capsules/hoofprint. The number of eggs and capsules collected/date also differed significantly ($P<.01$), but peaks in numbers did not always correspond with peaks in rainfall or adult mosquito collections. Hoofprint densities and herd movement did not influence egg distribution. Estimates of numbers of eggs and capsules on the 30 ha permanent pasture range from 2,633,621 in late February to 16,913,025 on June 2, 1980.

Mosquito oviposition was compared in hoofprint samples taken from a permanent pasture and a fallow rice field in Vermilion Parish, Louisiana during 1981. Hoofprints from the permanent pasture contained significantly ($P<.001$) more Ps. columbiae eggs than did hoofprints from the fallow rice field, averaging 3.3 and 1.9 eggs/hoofprint respectively. However, estimates of egg density in the 2 sites did not differ significantly ($P>.05$) since hoofprint density was greater in the fallow rice field. Egg density estimates were $15.2/m^2$ for the fallow rice field and $13.3/m^2$ for the permanent pasture. Hoofprint depth, hoofprint location, and cattle movement did not influence egg distribution.

Results of studies with caged Ps. columbiae exposed to natural lighting conditions indicated that the oviposition cycle was bimodal

with the main peak occurring in the 2 h period following sunset. This period coincides with peaks in flight activity, feeding activity, and swarming reported for this species in earlier studies.

Caged *Ps. columbiae* were exposed to soil that contained various percentages of moisture by weight. Average numbers of eggs deposited per cage in soil at 0, 20, 40, 60, and 80% moisture and in water differed significantly ($P<.004$) with 2.2, 30.2, 89.8, 28.3, 14.0, and 43.2 eggs/moisture level respectively. Cages of mosquitoes exposed to soil at 30, 40, 50, 60, 70, and 80% moisture by weight deposited 125.8, 188.6, 176.9, 39.6, 46.3, and 31.5 eggs/moisture level respectively. These averages were significantly different ($P<.008$).

INTRODUCTION

The research presented herein was conducted as part of a cooperative effort between the State Agricultural Experiment Stations of Arkansas, California, Louisiana, Mississippi and Texas and the Agricultural Research Service, USDA as part of the USDA/CSRS Southern Regional Project S-122 on the Biology, Ecology and Management of Riceland Mosquitoes in the Southern Region. Research objectives of the Riceland Mosquito Management Program include those which will supply information about the biological and ecological nature of riceland agroecosystems and man's influence on these systems as it pertains to mosquito population dynamics.

Pastures and rice fields are important breeding sites for mosquitoes. These mosquitoes must be considered a nuisance and a threat to the health of man and domestic animals. In Louisiana, fallow rice fields are often used as pastures for cattle which provide blood meals for mosquitoes as well as oviposition sites (hoofprints). It is important that we know the potential mosquito production of these sites so that control measures can be executed efficiently and effectively. Effective control depends on a thorough knowledge of the pest species. Objectives for this study were selected on the basis of gaps in the current literature concerning *Psorophora columbiae* (Dyar and Knab) oviposition in riceland pastures and oviposition behavior in general. Objectives chosen to be addressed were:

1. To compare the mosquito breeding potential of permanent pastures and fallow rice fields used as pastures.

2. To determine the relationship of mosquito egg distribution to cattle movement within a pasture.
3. To determine the preferred oviposition time of Ps. columbiae during a 24 h period.
4. To determine moisture content of riceland soils preferred by ovipositing Ps. columbiae.
5. To determine the preferred oviposition site of Ps. columbiae within hoofprints in relation to hoofprint depth and shading.
6. To determine the average fecundity for Ps. columbiae.

The following chapters concern efforts to resolve the first four of these objectives. Preliminary results from samples taken to determine the preferred oviposition site of Ps. columbiae within cattle hoofprints (objective 5) indicated that no differences existed in numbers of eggs deposited on hoofprint sides and bottoms. No further work was done on this objective since it was thought that effects of depth and shading on oviposition sites might be tested more easily and thoroughly in laboratory experiments. Further literature searches revealed that several studies (Schwardt 1939, Breeland and Pickard 1964 and Chapman and Woodard 1965) had already been conducted to determine average fecundity of Ps. columbiae. One of these studies (Chapman and Woodard 1965) was conducted with Louisiana mosquitoes.

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CHAPTER I

Abundance of Mosquito Eggs in a Permanent Pasture and Effects of Cattle Movement and Hoofprint Density on Egg Distribution

(Published in Southwestern Entomologist 8:273-278)

ABUNDANCE OF MOSQUITO EGGS IN A PERMANENT PASTURE AND EFFECTS OF CATTLE MOVEMENT AND HOOFPRINT DENSITY ON EGG DISTRIBUTION[1/]

D. C. Williams[2/], C. L. Meek[2/], and V. L. Wright[3/]

ABSTRACT

Cattle hoofprint samples from a permanent pasture in Vermilion Parish, Louisiana yielded an average of 9.2 eggs and capsules of Psorophora columbiae (Dyar and Knab)/hoofprint. Pasture sections differed significantly ($P<.0001$) in number of eggs and capsules/hoofprint. The section with the highest soil moisture averaged 20.6 eggs and capsules/hoofprint. Other sections ranged from 2.7 to 11.9 eggs and capsules/hoofprint. The number of eggs and capsules collected/date also differed significantly ($P<.01$), but peaks in numbers did not always correspond with peaks in rainfall and adult mosquito collections. Hoofprint densities and herd movement did not influence egg distribution. The percentage of hoofprints containing eggs and/or capsules ranged from 43 to 77. Estimates of total numbers of eggs and capsules on the 30 ha permanent pasture ranged from 2,633,621 in late February to 16,913,025 on June 2, 1980.

1/ This research was conducted as part of a cooperative effort between the State Agricultural Experiment Stations of Arkansas, California, Louisiana, Mississippi and Texas and the Agricultural Research Service, USDA as part of the USDA/CSRS Southern Regional Project S-122 on the Biology, Ecology and Management of Riceland Mosquitoes in the Southern Region.

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INTRODUCTION

The importance of cattle as blood hosts for the dark rice field mosquito, *Psorophora columbiae* (Dyar and Knab), has been well documented (Horsfall 1942, Whitehead 1952, Edman and Downe 1964, Schaefer and Steelman 1969, Edman 1971, Williams and Meisch 1981, Kuntz et al. 1982). Meek and Olson (1976, 1977) in Texas and Chambers et al. (1979) in Louisiana collected data indicating that cattle hoofprints in fallow rice fields used as pastures are important oviposition sites for *Ps. columbiae*. They also noted that the presence of cattle and freshness of hoofprints generally corresponded to increased numbers of mosquito eggs/hoofprint.

Permanent pastures which are not subjected to crop rotation lack the levees, borrow ditches, and tire tracks characteristic of fallow rice fields. These terrain features tend to maintain high soil moisture attractive to ovipositing floodwater mosquitoes. The present study was conducted to determine if permanent pastures were attractive breeding habitats for gravid females of *Ps. columbiae*. Efforts were made to assess the influence of cattle herd movement and of hoofprint density on the distribution of mosquito eggs within the pasture.

MATERIALS AND METHODS

The study was conducted in a 30 ha permanent pasture located on the Live Oak Plantation in Vermilion Parish, Louisiana. The rectangular pasture was typical of those located in south Louisiana in that it was adjacent to other pastures and in close proximity to fields planted in rice. The pasture was divided into 6 sections of

5 ha each (Fig. 1) and marked with wooden stakes at each corner of each section, permitting more accurate monitoring and recording of herd movement and a means of partitioning hoofprint soil samples and recording drainage patterns of the pasture.

The cattle herd maintained on the pasture consisted of 124 Brangus and Brangus X Simmental yearling heifers. Hoofprints were used as the basis of sampling since they were preferred to the flat soil surface by Ps. columbiae for oviposition sites (Meek and Olson 1976, Chambers et al. 1979). All hoofprints sampled during the study were deeper than 5 cm. They were removed from the pasture surface according to procedures outlined by Meek and Olson (1977).

Weekly estimates of hoofprint densities were obtained by counting hoofprints in 4 randomly selected 1 m^2 areas in each section of the pasture. These areas were selected by tossing a meter stick and counting the number of hoofprints present in a square meter area where the meter stick landed.

The first hoofprints were collected on February 26, 1980 to provide an index of the abundance of overwintering mosquito eggs. Weekly sampling of the pasture began on April 18 after the first collection of Ps. columbiae adults in a CDC light trap baited with dry ice. In early July the cattle were removed from the pasture due to insufficient forage caused by a prolonged dry period; however, sampling continued until July 31.

On each sampling date 10 hoofprints were collected/section for a total of 60 samples. Each sample was put in a plastic bag, labelled, and taken to the laboratory for processing. Unhatched

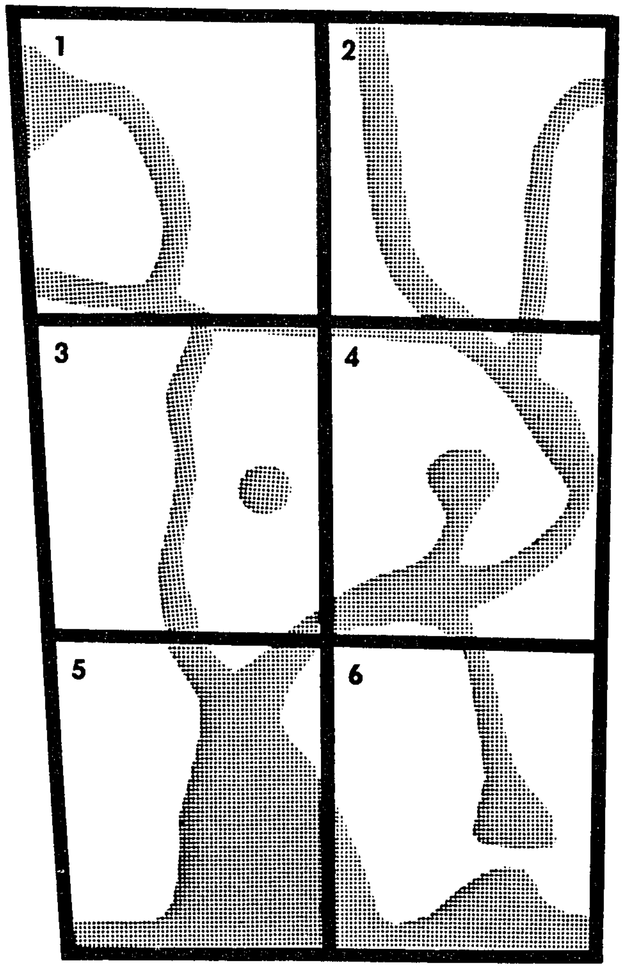

Figure 1. Drainage patterns in a permanent pasture in south Louisiana. Stippled areas indicate areas of low elevation.

eggs and ruptured or hatched eggs (hereafter referred to as capsules) were removed from samples using a modification of soil washing and salt flotation techniques described by Horsfall (1956). Eggs and capsules were identified using the taxonomic key of Ross and Horsfall (1965). In order to determine the efficiency of egg recovery from soil samples using these techniques, soil samples with a known number of eggs were processed. Recovery rate from these test samples was 80%. Periodic checks were conducted throughout the study to verify consistency in the percentage of eggs recovered from the soil samples.

During the course of the study, movement of the cattle herd within the pasture was recorded over a 24 hr period on 5 separate occasions. The number of heifers present in each section was counted at 3 hr intervals. At night, a truck was driven around the perimeter of the pasture and a spotlight was used to locate individual animals.

The species composition and relative abundance of adult mosquitoes were determined on each sampling date using a CDC light trap baited with dry ice. Also, during the study, daily temperatures and rainfall were continuously recorded to determine their influence on the abundance of mosquito eggs and adult mosquitoes in the pasture.

RESULTS AND DISCUSSION

A total of 840 hoofprint samples were collected during the entire study and from those samples 7,085 mosquito eggs and capsules were recorded. Only 2 mosquito species were represented. Ps.

columbiae accounted for 99.5% of the eggs and capsules while Ps. ciliata (Fab.) was marginally represented with 0.5%. The predominance of Ps. columbiae in this study is consistent with data from fallow rice fields used as pastures in south Louisiana as reported by Chambers et al. (1979). These authors indicated that Ps. columbiae, Aedes sollicitans (Walker), and Ps. ciliata accounted for 91, 8, and 1% of the egg population collected, respectively. We did not record any Ae. sollicitans eggs in this study which may be due, in part, to 2 factors: (1) preference of Ae. sollicitans for ovipositing on flat soil surfaces (Chambers et al. 1979); and (2) a relatively low incidence of Ae. sollicitans adults in the vicinity of the study pasture. From light trap collections only 486 adults of Ae. sollicitans were recorded from March through July as compared to 99,627 Ps. columbiae adults for the same period.

An analysis of variance was conducted on the mean number of eggs and capsules collected/hoofprint and highly significant differences ($P<.0001$) were found among different sections of the field. Section 5 had significantly higher mean number of eggs and capsules than any other section ($P<.05$) with a seasonal average of 20.58 eggs and capsules/hoofprint (Table 1). As seen in Fig. 1, this particular section was located in the lower portion of the pasture and therefore received most of the drainage water, producing prolonged periods of high soil moisture which were attractive to ovipositing Ps. columbiae. When positive hoofprints were considered (i.e. containing at least one egg or capsule), the mean number/hoofprint ranged from 4.82 to 26.74. The percentage of

TABLE 1. Psorophora columbiae Eggs and Capsules Found in Cattle Hoofprints in Each 5 ha Section of a 30 ha Pasture in Vermilion Parish, LA (February-July 1980).

Section	Mean Number/Hoofprint: All hoofprints	Mean Number/Hoofprint: Positive hoofprints[a/]	% of + hoof-prints	Hoofprints /m²	Cattle use index[b/]
1	3.20 (7.09)[c/]	6.54 (9.03)	49	2.82 (3.06)	522
2	9.10 (26.82)	14.90 (33.12)	61	2.73 (4.37)	1195
3	11.86 (33.68)	17.05 (39.32)	70	3.95 (5.52)	979
4	7.53 (16.93)	13.24 (20.75)	57	2.80 (4.11)	760
5	20.58 (31.48)	26.74 (33.53)	77	3.27 (3.59)	1001
6	2.67 (5.62)	4.82 (6.84)	55	1.34 (2.99)	502

a/ Hoofprints with at least 1 egg or capsule.
b/ Total animals/section for 5 separate 24 hr periods.
c/ Numbers in parentheses are standard deviations.

positive hoofprints from each section ranged from 49 to 77%.

The average number of hoofprints/m^2 and the total number of cattle/section for a 24 hr period on 5 dates are also listed in Table 1. Spearman's coefficient of rank correlation was calculated in order to determine if significant associations existed between mean hoofprint density/section and mean number of eggs and capsules/section and between cattle/section and mean number of eggs and capsules/section. Neither association was significant.

The mean numbers of eggs and capsules/hoofprint/collection date and the mean number of eggs and capsules/positive hoofprint/collection date are listed in Table 2. Mean number of eggs and capsules/hoofprint/collection date ranged from 1.58 on February 26 to 14.95 on June 2. The percentage of hoofprints that contained eggs ranged from 43% on February 26 to 77% on April 29 (Table 2). Analysis of variance on numbers of eggs and capsules/date indicated that sampling dates differed significantly ($P<.01$).

The mean number of eggs and capsules/hoofprint multiplied by the mean hoofprint density/section for each date estimated the total number of eggs and capsules in the pasture on each sampling date. These estimates ranged from 2,633,621 in late February to 16,913,025 on June 2. These numbers do not represent potential larvae since eggs and capsules were counted.

Peaks in eggs numbers were not always synchronous with peaks in the adult *Ps. columbiae* populations. Adult *Ps. columbiae* totaled more than 10,000 in the collections of June 9, June 16, July 7, and

TABLE 2. *Psorophora columbiae* Eggs and Capsules Found in Cattle Hoofprints in a 30 ha Permanent Pasture in Vermilion Parish, LA (1980).

Date	Mean Number/Hoofprint: All hoofprints	Mean Number/Hoofprint: Positive hoofprints[a]	% of positive hoofprints[a]	Estimate for 30 ha (millions)
Feb 26	1.58 (4.53)[b]	3.72 (6.42)	43	2.6 (1.0)
Apr 18	2.42 (6.81)	4.61 (8.91)	53	4.6 (1.4)
29	13.82 (27.24)	17.91 (29.86)	77	11.8 (3.5)
May 8	9.18 (14.18)	12.24 (15.21)	75	11.2 (2.2)
26	2.78 (8.24)	4.82 (10.44)	58	2.8 (1.1)
Jun 2	14.95 (28.78)	21.15 (32.34)	70	17.0 (3.2)
9	12.00 (29.94)	24.83 (39.49)	48	8.8 (2.1)
16	14.15 (40.62)	20.37 (47.56)	69	8.8 (3.7)
24	11.26 (17.47)	16.05 (18.95)	70	4.3 (0.9)
30	7.34 (10.38)	11.21 (11.03)	65	4.7 (0.9
Jul 7	5.93 (18.29)	11.87 (24.65)	50	3.3 (1.6)
14	10.15 (30.47)	17.91 (38.94)	57	4.0 (1.9)
21	11.53 (31.25)	16.88 (36.72)	68	5.0 (1.1)
31	11.65 (26.77)	19.97 (32.75)	58	4.4 (1.6)

[a] Hoofprints with at least 1 egg or capsule.
[b] Numbers in parentheses are standard deviations.

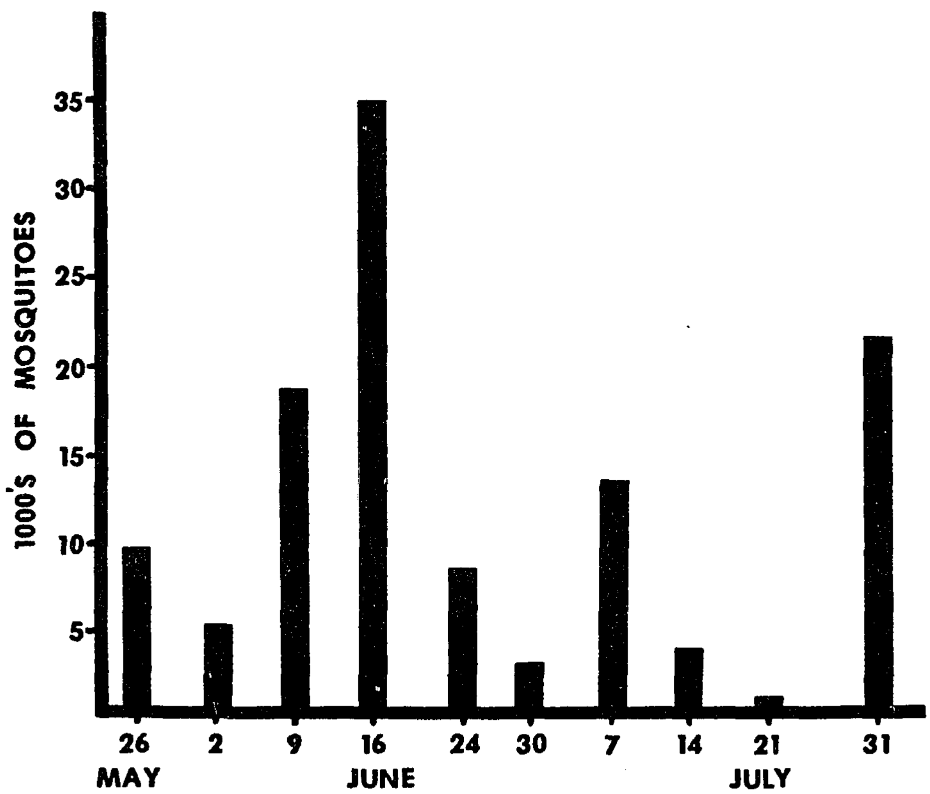

Figure 2. Adult Psorophora columbiae collected in one CO_2 baited CDC light trap in south Louisiana (1980).

July 31. June 16 was the peak collection date with 35,000 adult Ps. columbiae captured (Fig. 2). Numbers of eggs and capsules averaged more than 10/hoofprint on April 29, June 2, 9, 16, 24 and July 14, 21, 31. Dates which averaged more than 12 eggs and capsules/ hoofprint were April 29 and June 2 and 16 (Table 2). Rainfall did not appear to influence egg numbers. The pasture received 29.01 cm of rain from May 8 to May 26. After May 26, total weekly rainfall exceeded 1.27 cm for only 3 weeks. The weeks beginning June 16, June 30, and July 21 received 6.35, 1.68, and 7.70 cm, respectively.

The results of this study indicate that permanent pastures serve as important oviposition sites for Ps columbiae in the riceland areas of south Louisiana. Soil moisture patterns in the pasture influenced egg distribution to the extent that more eggs were laid in wetter sections. However, cattle movement and hoofprint density had no influence on egg distribution. Perhaps with more uniform soil moisture these factors would exert more influence on egg distribution.

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CHAPTER II

Comparison of Mosquito Oviposition in a Fallow Rice Field and a Permanent Pasture in South Louisiana

(In press at Southwestern Entomologist)

COMPARISON OF MOSQUITO[1/] OVIPOSITION IN A FALLOW RICE FIELD AND A PERMANENT PASTURE IN SOUTH LOUISIANA[2/]

D. C. Williams[3/], C. L. Meek[3/], and V. L. Wright[4/]

ABSTRACT

Cattle hoofprint samples were taken from a permanent pasture and a fallow rice field in Vermilion Parish, Louisiana. Hoofprints from the permanent pasture contained significantly ($P<0.001$) more Psorophora columbiae (Dyar and Knab) eggs than did hoofprints from the fallow rice field. Hoofprints from the permanent pasture and the fallow rice field averaged 3.3 and 1.9 eggs/hoofprint respectively. However, estimates of egg density in the 2 pastures did not differ significantly ($P>0.05$) since hoofprint density was greater ($P<0.001$) in the fallow rice field than in the permanent pasture. Egg density estimates were $15.2/m^2$ for the fallow rice field and $13.3/m^2$ for the permanent pasture. Hoofprint depth, hoofprint location within the fallow rice field, and cattle movement did not influence egg distribution.

1/ Diptera: Culicidae

2/ This research was conducted as part of a cooperative effort between the State Agricultural Experiment Stations of Arkansas, California, Louisiana, Mississippi and Texas and the Agricultural Research Service, USDA as part of the USDA/CSRS Southern Regional Project S-122 on the Biology, Ecology and Management of Riceland Mosquitoes in the Southern Region.

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INTRODUCTION

In south Louisiana, Williams et al. (1983) conducted research that indicated cattle hoofprints in permanent pastures are important oviposition sites for *Psorophora columbiae* (Dyar and Knab). Earlier research by Meek and Olson (1976, 1977) in Texas and Chambers et al. (1979) in Louisiana demonstrated that cattle hoofprints in fallow rice fields used as pastures are similarly important oviposition sites. However, there are dramatic differences between fallow rice fields used as pasture and permanent pastures. Fallow rice fields contain earthen structures (levees and borrow ditches) associated with rice flooding and often have deep tractor and combine tire tracks remaining after harvest. These features often retain water and increase soil moisture so that the soil is attractive to ovipositing female mosquitoes. Permanent pastures lack these structures but retain natural drainage patterns. In light of these topographic differences and because both pastures are used as oviposition sites for *Ps. columbiae*, studies were conducted to determine which pasture is more attractive to ovipositing *Ps. columbiae* and what factors might contribute to any differences in attractiveness.

MATERIALS AND METHODS

Study sites were located south of Abbeville in Vermilion Parish, LA. The 7.3 ha permanent pasture contained 15 Brahman heifers and 3 horses. The 24.3 ha fallow rice field contained 46 Brahman and Brahman-mix cows and calves and was located less than 4.8 km from the permanent pasture. Levees, borrow ditches, and combine and tractor tire tracks were evident throughout the fallow rice field.

Both pastures were divided into 6 equal sections to aid in partitioning hoofprint samples and were sampled according to Williams et al. (1983). Sections of the permanent pasture were marked with reflector-topped stakes to aid in monitoring herd movement. Although previous data indicated that herd movement did not influence egg distribution, cattle movement was again monitored to see if its influence on egg distribution might become evident on a pasture with very little relief. Five samples were taken from each pasture section each week for a total of 30 hoofprint samples from each pasture every sampling date.

Each hoofprint was measured for depth, collected according to the procedure outlined by Meek and Olson (1977), placed in a plastic bag, labelled, and taken to the laboratory for processing. Eggs and capsules were removed from samples using a modification of soil washing and salt flotation techniques described by Horsfall (1956). Eggs and capsules were identified using the taxonomic key of Ross and Horsfall (1965). Weekly sampling began on May 15 and continued until September 3 for the fallow rice field and until September 15 for the permanent pasture unless otherwise prevented due to flooded fields. Flooding occurred more often in the fallow rice field than in the permanent pasture because the levees and tire tracks inhibited drainage. Sampling was discontinued in September when the fields were plowed and/or cattle removed.

Adult mosquito collections were made one night weekly at each pasture using CDC light traps baited with dry ice. Temperature, humidity, and rainfall were monitored at the fallow rice field site. Data from the permanent pasture and the fallow rice field and from the different locations in the fallow rice field were subjected to an analysis of variance using SAS general linear models procedure for testing the hypothesis that the means obtained from the different sites and locations were equal. Spearman's coefficient of rank correlation was calculated in order to determine if a significant association existed between cattle usage and mean mosquito eggs per section of the permanent pasture.

RESULTS AND DISCUSSION

Adult collections indicated that *Ps. columbiae* and *Culex salinarius* (Coquillett) were the most abundant mosquitoes. Approximately 45,000 adults of each species were collected at the permanent pasture over 14 collection dates. Numbers were similar at the fallow rice field. *Anopheles crucians* Wiedemann was next in abundance, with about 18,000 collected at the permanent pasture and 9,000 at the fallow rice field. *Aedes sollicitans* (Walker) was similar in abundance to *An. crucians*, with 18,000 collected at the permanent pasture and 1300 at the fallow rice field. Other species captured regularly, but in lesser abundance, were *Ae. vexans* (Meigen), *An. quadrimaculatus* (Say), *Ps. ciliata* (Fabricius), and *Cx. erraticus* (Dyar and Knab).

Two hundred ninety hoofprint samples were taken from the fallow rice field and 358 from the permanent pasture. The majority of mosquito eggs collected were *Ps. columbiae* (99.5%), whereas *Ps.*

ciliata accounted for 0.5%. These data are similar to those in previous studies in a permanent pasture by Williams et al. (1983).

Mean number of Ps. columbiae eggs and capsules/hoofprint, percentage of positive hoofprints (hoofprints containing at least 1 egg or capsule), mean hoofprint density, mean egg density, mean hoofprint depth, and the number of adult Ps. columbiae recorded for each collection date for the permanent pasture and fallow rice field are listed in Tables 1 and 2 respectively. The mean number of eggs/hoofprint in the permanent pasture varied from 1.4 on September 15 to 7.2 on May 20. In the fallow rice field, mean eggs/hoofprint varied from 0.5 on May 26 to 3.4 on August 3. As in the previous study (Williams et al. 1983), peaks in egg numbers did not correspond to peaks in adult numbers for either field. Adult Ps. columbiae collections were greatest in early June and early to mid-August.

The mean number of eggs and capsules/hoofprint in the permanent pasture ranged from 2.9 on July 21 to 19.9 on May 15. Values for the fallow rice field were usually less than in the permanent pasture, ranging from 2.0 on May 26 to 6.9 on May 15. This is comparable to the number of eggs and capsules/hoofprint recorded by Williams et al. (1983).

The percentages of positive hoofprints were consistent for the pastures throughout the study period. For both the permanent pasture and the fallow rice field, the percentage ranged from 75 to 83 depending on sampling date.

Hoofprint densities were recorded so that estimates of egg

TABLE 1. Psorophora columbiae Eggs/Hoofprint, Eggs and Capsules/Hoofprint, Hoofprint Depth and Density, Egg Density, and Adult Light Trap Collections from a Permanent Pasture in South Louisiana.

Date		N	Eggs/ hoofprint	N	Eggs and Capsules/ hoofprint	Positive Hoofprints (%)[a]	N	Hoofprint density/m²	N	Eggs/m²[b]	N	Hoofprint depth(cm)	Adult Ps. columbiae[c]
May	15	30	5.8 (12.8)[d]	30	19.9 (36.1)	58	12	6.3 (1.8)	12	18.4 (26.7)	-	-	2032
	20	30	7.2 (16.1)	30	11.3 (22.8)	59	12	4.9 (1.8)	12	27.9 (51.4)	-	-	360
	26	30	2.0 (3.7)	30	6.4 (15.8)	57	12	7.8 (2.0)	12	15.3 (20.2)	-	-	3816
June	2	30	2.7 (4.8)	30	4.8 (6.4)	58	12	6.9 (2.6)	12	33.4 (45.5)	-	-	5888
	18	30	2.2 (4.0)	30	4.7 (8.4)	57	30	5.1 (1.5)	30	10.9 (21.3)	-	-	680
July	13	29	2.4 (5.4)	29	5.6 (8.8)	57	29	4.0 (1.7)	29	10.3 (19.5)	29	3.6 (1.2)	1216
	21	29	1.6 (1.7)	29	2.9 (2.6)	57	30	5.8 (2.4)	29	8.7 (8.6)	30	3.7 (1.2)	1634
August	3	30	3.6 (7.2)	30	6.7 (10.9)	57	30	4.6 (2.1)	30	14.9 (30.6)	30	3.1 (0.7)	5984
	12	30	3.4 (6.9)	30	5.4 (9.2)	57	30	4.3 (1.5)	30	14.7 (33.6)	30	3.0 (0.8)	11992
	27	30	3.2 (5.2)	30	7.8 (9.8)	57	30	3.8 (2.0)	30	15.1 (31.4)	30	2.9 (0.6)	-
Sept.	3	30	4.0 (6.4)	30	10.9 (21.9)	58	30	2.8 (1.5)	30	12.1 (18.9)	30	3.5 (0.8)	579
	15	30	1.4 (2.0)	30	4.8 (5.2)	58	30	2.0 (1.2)	30	3.4 (6.3)	30	3.4 (0.9)	25

a/ Hoofprints with at least 1 egg or capsule.
b/ Egg density was estimated by multiplying eggs/hoofprint at one sample site by hoofprint density at the same location and averaging the resulting densities from the pasture.
c/ Total collected over 15 collection nights.
d/ Standard deviation.

TABLE 2. *Psorophora columbiae* Eggs/Hoofprint, Eggs and Capsules/Hoofprint, Hoofprint Depth and Density, Egg Density, and Adult Light Trap Collections from a Fallow Rice Field in South Louisiana.

Date		N	Eggs/ hoofprint	N	Eggs and Capsules/ hoofprint	Hoofprints (%)[a]	N	Hoofprint density/m^2	N	Eggs/m^2[b]	N	Hoofprint depth(cm)	Adult *Ps. columbiae*[c]
May	15	30	1.0 (1.0)[d]	30	6.9 (9.2)	57	12	4.8 (1.9)	12	2.6 (4.3)	-	-	-
	20	30	2.3 (6.1)	30	6.0 (12.6)	58	12	7.3 (3.6)	12	23.2 (46.8)	-	-	178
	26	30	0.5 (0.9)	30	2.0 (3.6)	51	12	10.2 (2.4)	12	5.8 (9.6)	-	-	2616
June	2	30	1.9 (3.5)	30	6.0 (7.7)	52	12	8.2 (3.0)	30	15.7 (29.5)	-	-	6560
	18	21	1.5 (3.2)	21	6.2 (8.3)	50	21	4.2 (2.6)	21	7.0 (16.5)	-	-	748
July	21	29	1.6 (2.1)	29	5.1 (7.5)	52	30	8.7 (3.8)	29	14.7 (24.5)	30	6.4 (1.8)	4368
August	3	30	3.4 (5.6)	30	5.9 (7.0)	55	30	7.6 (2.8)	30	32.0 (59.6)	30	4.9 (1.8)	1676
	12	30	3.3 (6.3)	30	6.6 (7.7)	58	30	7.3 (3.0)	30	27.8 (52.9)	30	4.8 (1.8)	5188
	27	30	0.6 (0.9)	30	3.4 (4.0)	56	30	5.1 (1.7)	30	3.1 (3.7)	30	4.8 (1.3)	-
Sept.	3	30	2.2 (4.5)	30	6.3 (7.7)	57	30	4.2 (2.5)	30	9.6 (22.6)	30	5.0 (1.8)	3422

[a] Hoofprints with at least 1 egg or capsule.
[b] Egg density was estimated by multiplying eggs/hoofprint at one sample site by hoofprint density at the same location and averaging the resulting densities from the pasture.
[c] Total collected over 14 collection nights.
[d] Standard deviation.

densities could be made within each pasture. Hoofprint densities ranged from 2.0 to 7.8 hoofprints/m^2 in the permanent pasture and from 4.2 to 10.2 hoofprints/m^2 in the fallow rice field. Egg density was estimated by multiplying eggs/hoofprint at one sample site by hoofprint density at the same location and averaging the resulting densities for the pasture. Egg density estimates are based on a recovery rate of 80% and, therefore, do not reflect total egg density. Also, egg density estimates do not take into account eggs which may have been deposited on flat soil surfaces. In both pastures, egg density ranged from approximately 3 eggs/m^2 to 33 egg/m^2.

Hoofprint depth was fairly consistent within each field, although hoofprints in the fallow rice field were always deeper on the average. Hoofprints in the permanent pasture ranged from 2.9 to 3.7 cm in depth, whereas those in the fallow rice field ranged from 4.8 to 6.4 cm in depth.

Means and standard deviations of number of eggs/hoofprint, eggs and capsules/hoofprint, hoofprint density, eggs/m^2, and hoofprint depth are listed in Table 3. The permanent pasture and fallow rice field differed significantly in the number of eggs/hoofprint ($P<0.001$). The permanent pasture averaged 3.3 eggs/hoofprint and the fallow rice field averaged 1.9. The average numbers of eggs and capsules/hoofprint differed significantly for the 2 sites ($P<0.014$). The permanent pasture averaged 7.6 eggs and capsules/hoofprint and the fallow rice field averaged 5.4.

Although eggs/hoofprint was greater in the permanent pasture,

TABLE 3. Means and Standard Deviations of Eggs/Hoofprint, Eggs and Capsules/Hoofprint, Hoofprints/m^2, Eggs/m^2 and Hoofprint Depth for a Permanent Pasture and a Fallow Rice Field Used as a Pasture in South Louisiana.

	Permanent Pature			Fallow Rice Field		
	N	$\bar{X}$	Standard deviation	N	$\bar{X}$	Standard deviation
Eggs/hoofprint[a/]	359	3.3	(7.6)	290	1.9	(4.1)
Eggs and capsules/ hoofprint[b/]	359	7.6	(16.4)	290	5.4	(7.9)
Hoofprints/m^2[a/]	288	4.4	(3.3)	219	6.6	(3.3)
Eggs/m^2[c/]	287	13.3	(26.6)	218	15.2	(36.0)
Hoofprint depth (cm)[a/]	210	3.3	(1.0)	150	5.2	(1.8)

a/ Sites differed significantly at $P<0.001$.
b/ Sites differed significantly at $P<0.014$.
c/ Sites were not significantly different at $P>0.05$.

hoofprint density was significantly greater ($P<0.001$) in the fallow rice field. Hoofprint density averaged $6.6/m^2$ in the fallow rice field and $4.4/m^2$ in the permanent pasture. When estimates of eggs/m^2 were compared, the pastures did not differ significantly ($P>0.05$). Egg density estimates were $15.2/m^2$ for the fallow rice field and $13.3/m^2$ in the permanent pasture.

Hoofprint depth was significantly greater ($P<0.001$) in the fallow rice field than in the permanent pasture. Although we measured hoofprint depth in anticipation that it would provide an indication of soil moisture and aid in mapping distribution of mosquito eggs, hoofprint depth apparently was not an indication of egg distribution. Since levees remained in the fallow rice field we thought the concentration of eggs might be greater nearer these moisture retaining structures and that hoofprint density and depth might give us an indication of the soil moisture and, hence, of the egg distribution. Hoofprints collected from the fallow rice field were marked as to location in the field: the first 1 m of the borrow ditch next to the levee, within the first 11 m of the pan, and in the middle of the pan. (The pan is the area of the field on which the rice is grown). Means of eggs/hoofprint, eggs and capsules/ hoofprint, hoofprint density, and hoofprint depth for the 3 locations are listed on Table 4. Although the mean number of eggs/hoofprint was greater along the levee, with 2.5 eggs/hoofprint compared to 1.9 for both the side of the pan and the middle of the pan, this difference was not significant ($P>0.05$). The mean eggs and capsules/hoofprint, hoofprint density, and hoofprint depth at

TABLE 4. Mean Numbers of Eggs/Hoofprint, Eggs and Capsules/Hoofprint, Hoofprints/m^2, and Hoofprint Depth for 3 Locations in a Fallow Rice Field Used as Pasture in South Louisiana.

	Levee ditch[a/]	Side of pan[b/]	Middle of pan
Eggs/hoofprint[c/]	2.5	1.9	1.9
Eggs and capsules/hoofprint	5.1	5.7	6.1
Hoofprints/m^2	6.5	6.2	6.1
Hoofprint depth (cm)	5.2	5.1	5.4

a/ Within 1 m from levee
b/ Between 1 m to 11 m from levee
c/ Means for eggs/hoofprint, eggs and capsules/hoofprint, hoofprints/m^2 and hoofprint depth did not differ significantly for the 3 locations.

the 3 locations did not differ significantly either (Table 4). There was more variation within each location than between them for all 3 variables.

As in the 1980 study, we could not demonstrate that cattle movement had any influence on egg distribution even though the topography was more even in this pasture than in the pasture studied in 1980.

Although there appeared to be dramatic differences between the permanent pasture and fallow rice field in soil moisture and vegetation, the differences were not sufficient to influence the overall density of *Ps. columbiae* eggs. Soil moisture in the fallow rice field was apparently high enough that it influenced hoofprint density and hoofprint depth, but we found no influence of hoofprint depth on egg distribution, at least in the range of depths found in these fields. Increased hoofprint density only served to dilute the mean number of eggs/hoofprint and did not increase oviposition. In summary, it appears that both permanent pastures and fallow rice fields used as pasture have the potential to produce similar numbers of mosquitoes.

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CHAPTER III

Observations of the Oviposition Cycle of Caged *Psorophora columbiae* (Dyar and Knab) Exposed to Natural Light Conditions

ABSTRACT

Results of studies with caged adults of *Psorophora columbiae* (Dyar and Knab) exposed to natural lighting conditions indicated that the oviposition cycle was bimodal with the peak in oviposition occurring in the 2 h period following sunset. This period coincides with peaks in flight activity, feeding activity, and swarming reported for this species in earlier studies.

INTRODUCTION

Oviposition cycles have been studied in relatively few species of mosquitoes. Haddow and Gillett (1957) initiated a series of oviposition cycle studies on *Aedes aegypti* (Linneaus) and found that oviposition activity peaked in late afternoon for this species. A similar oviposition cycle for *Ae. aegypti* was observed in the field by McClelland in Kenya (1968). The oviposition cycle of *Ae. africanus* Theobald was found by Gillett and Haddow (1957) to resemble that described for *Ae. aegypti*. When studying *Ae. apicoargenteus* Theobald, Haddow, et al. (1960) found oviposition was diurnal and cyclical and broadly resembled the biting cycle although the peak in biting activity followed the peak in oviposition. They also found that peaks in biting activity followed peaks in oviposition in *Ae. aegypti* and *Ae. africanus*. Haddow and Gillett (1958) investigated the oviposition cycle of *Taeniorhynchus fuscopennatus* Theobald and found that oviposition and biting activity were mainly nocturnal and bimodal with peaks early in the night and before sunrise. In this study the major peak oviposition occurred before sunrise and the major peak in biting activity occurred soon after sunset. Laboratory studies of Anopheles gambiae Giles by Haddow and Ssenkubuge (1962) indicated that peak oviposition occurred in the hour following sunset and was unimodal. In one of the latest studies of oviposition cycles in mosquitoes, Suleman and Shirin (1981) found that oviposition activity in Culex quinquefasciatus Say was limited almost entirely to the scotophase and peaked in the period from 3 h to 5 h after the beginning of the scotophase. In this study biting and mating activity resembled that of oviposition except that biting was trimodal and mating bimodal.

Although we were unable to find any mention of the oviposition cycle of Psorophora columbiae (Dyar and Knab) in the literature there have been several observations made concerning the time of peak flight activity in this species. Horsfall (1955) found that, based on light trap collections made in Arkansas, most movement of Ps. columbiae occurred prior to midnight. Over 50% of the Ps. columbiae captured by Horsfall were captured in the first 3 h of darkness. Al-Azawi and Chew (1959) noted that light trap collections of Ps. columbiae in California reached a peak 2 to 3 h after sunset and then gradually decreased. On 2 occasions of light-trapping with CO_2 for 5 consecutive nights in Bolivar County, Mississippi researchers found that Ps columbiae numbers peaked at 2 and 3 h after sunset (Olson 1983). Steelman et al. (1972) noted that larger numbers of blood-fed mosquitoes (including Ps. columbiae) were observed 60, 90, and 120 min after sunset than at 30 min after sunset and that the rate of increase was less from 90-120 min after sunset than in the first 90 min. One other indication of activity cycles is found in swarming reports from Texas (Olson 1983). *Ps. columbiae* swarms were observed in the evenings beginning about 10 min after sunset and in the morning about 1 h before sunrise.

Due to the lack of information on the oviposition cycle by *Ps. columbiae* and preliminary observations of oviposition in *Ps. columbiae* kept in the laboratory we undertook this study to determine the peak period of oviposition in *Ps. columbiae* and compare this to activity noted by others for this species.

MATERIALS AND METHODS

Mosquitoes for this study were collected in Jefferson Davis Parish, LA using CDC light traps with dry ice. These mosquitoes were transported to the laboratory in 30 cm square screen cages covered with damp towels. At the laboratory ♀ *Ps. columbiae* were transferred to 20.5 cm x 8.5 cm x 8.0 cm cages with aluminum window screening on 2 opposing sides and 3.2 mm clear plexiglass making up the other sides. Both ends were also 3.2 mm thick plexiglass with 1 end having a 4 cm hole in it for the introduction of the mosquitoes. Initially 20 ♀ *Ps. columbiae* were introduced into each cage, but the actual number in the cages at the time of the tests varied from 4 to 17 due to mortality. Soaked raisins covered with moistened paper towel pads were kept on top of the cages at all times to provide mosquitoes with a carbohydrate source. Mosquitoes were offered human blood meals 4 and 3 days prior to beginning the tests. Cages were placed on cheesecloth pads in open 34 cm x 26 cm x 9 cm deep plastic shoe boxes lined with moistened cellucotton. The shoe boxes were tilted at an approximately 20° angle and free water was kept standing in the lower end. Boxes were placed on a table in a roofed, screened enclosure outdoors so that mosquitoes were subjected to the current light conditions. Tests were conducted by changing the cheesecloth pads under the cages every 2 h and replacing them with new, moist cheesecloth pads. Tests were started at various times of day, but so that one 2 h period would begin at sunset. After the pads were removed, they were set aside for several hours so that all the eggs could darken. Eggs were counted using a binocular microscope. Data presented in this paper represent results of tests begun on July 22, July 28, and August 12 of 1983. Sunset on these days and sunrise on the next day began at 7:40 p.m. and 6:40 a.m., 7:34 p.m. and 6:39 a.m., and 7:15 p.m. and 6:47 a.m., respectively for the 3 dates. Eleven cages were used in the July test and 12 cages on each of the July 28 and August 12 tests.

Transformed data from the different time periods were subjected to an analysis of variance using SAS general linear models procedure to test the hypothesis that the mean numbers of eggs laid during the time periods were equal. To equalize the variances, data were transformed by taking the square root of the numbers of eggs.

A "t" test was performed to test the hypothesis that the mean number of eggs laid at night was equal to the mean number of eggs laid during the day.

RESULTS AND DISCUSSION

The results of this study are given in Table 1. The results of a "t" test indicate that significantly more eggs were laid at night than during the day. An average of 140.3 eggs/cage were laid per night of tests and an average of 49.2 eggs/cage were laid per day of tests. Analysis of variance revealed that time periods were highly significantly different ($P<.001$). More eggs were deposited in the 2 h period following sunset than in any of the other periods. The mean number of eggs/cage laid in the 2 h following sunset was 49.8. During the next time period 27.5 eggs/cage were recorded. After this the number of eggs/cage gradually decreased until dropping off from 16.5 eggs/cage for the period which was hours 2 and 3 before sunrise to 4.1 eggs/cage for the period which included sunrise. Mean eggs/cage dropped to its lowest point for the 24 h in the next 2 h period when an average of 3.2 eggs/cage were recovered. A small peak in oviposition occurred mid-day when 13.3 eggs/cage were recorded.

Thus the oviposition cycle of *Ps. columbiae* in this experiment was bimodal with the main peak occurring in the 2 h following sunset (Figure 1). This peak coincides with the peak in collections recorded by Horsfall (1955), Al-Azawi and Chew (1959) and Riceland Mosquito Management Project Researchers in Mississippi (Olson 1983). The peak we have described also coincides with observations by Steelman et al. (1972) concerning the number of blood-fed mosquitoes (including *Ps. columbiae*) resting on barn walls. Swarming by *Ps. columbiae* observed by Peloquin and Olson in Texas (Olson 1983) also

Table 1. Diel periodicity of oviposition by caged *Psorophora columbiae* at Baton Rouge, LA. [1/]

2 h time periods	N	Mean eggs/cage	Standard deviation
1	35	5.0	5.3
2	35	8.1	13.1
3	35	12.0	16.5
4 [2/]	35	49.8	67.9
5	35	27.5	29.5
6	35	23.7	30.0
7	35	18.7	31.3
8	35	16.5	23.7
9 [3/]	35	4.1	5.7
10	35	3.2	4.2
11	35	7.6	9.0
12	35	13.3	16.2

1/ Data presented are from 3 observations of 24 h each.
2/ The beginning of period 4 coincided with sunset.
3/ Sunrise occurred approximately in the middle of period 9.

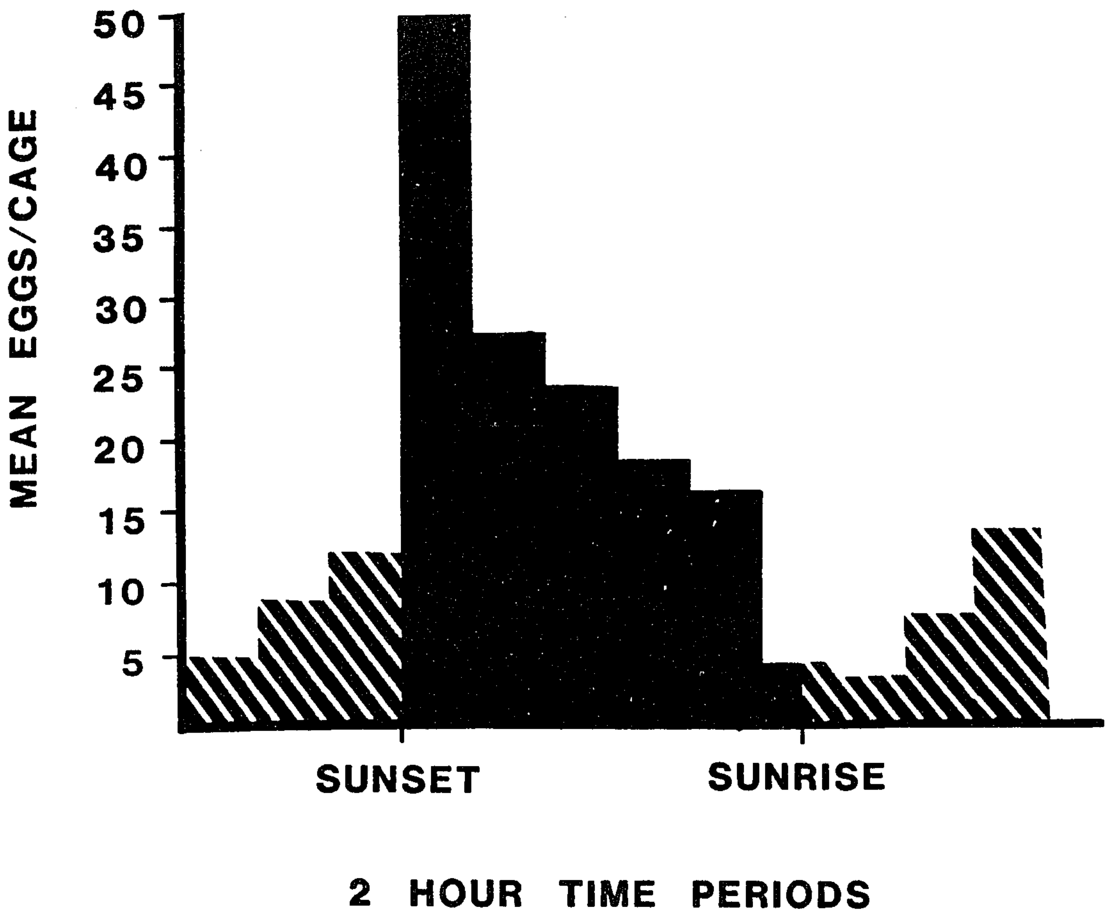

Figure 1. Diel periodicity of oviposition by caged *Psorophora columbiae* at Baton Rouge, LA.

occurred soon after sunset; however they also observed swarming activity prior to sunrise.

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CHAPTER IV

Moisture Preferences of Ovipositing *Psorophora columbiae* (Dyar and Knab)

Moisture Preferences of Ovipositing *Psorophora columbiae* (Dyar and Knab)

ABSTRACT

Caged *Psorophora columbiae* (Dyar and Knab) were exposed to soil that contained various moisture %'s by weight. Average numbers of eggs deposited per cage in soil at 0, 20, 40, 60 and 80% and in water differed significantly ($P<.004$) with 2.2, 30.2, 89.8, 28.3, 14.0 and 43.2 eggs/moisture level respectively. There was a significant ($P<.001$) quadratic effect in this moisture series. When the interval between moisture levels was reduced to 10% and cages of mosquitoes presented with soil at 30, 40, 50, 60, 70 and 80% moisture by weight, mean numbers of eggs/moisture level were 125.8, 188.6, 176.9, 39.6, 46.3 and 31.5 respectively. These averages were significantly different ($P<.008$) and there was a significant linear effect ($P<.001$).

INTRODUCTION

Investigation of soil moisture preference of ovipositing floodwater mosquitoes has been approached in several ways. Knight and Baker (1962) made laboratory determinations of substrate mositre preference of *Aedes taeniorhynchus* (Wiedemann) and *Ae. sollicitans* (Walker) ovipositing on gauze pads. Horsfall (1963) described the distribution of floodwater mosquitoes in the field. The field distribution of *Ae. stimulans* (Walker) eggs was studied by McDaniel and Horsfall (1963).

Several workers have studied the moisture preference of ovipositing Ae. vexans (Miegen) on various substrates in the laboratory (Russo 1977, Strickman 1980) and in the field (Horsfall et al. 1975, Cassani and Bland 1978, Strickman 1980, and Novak 1981).

Field and laboratory studies of the soil moisture preference of ovipositing Psorophora columbiae (Dyar and Knab) have been conducted by Olson and Meek (1977, 1980). In studying the moisture preference of Ps. columbiae in the laboratory they found that most eggs were deposited on soil which ranged from 75% field capacity to just above field capacity. Field capacity is defined by Box and Bennett (1959) as the maximum amount of water that a given soil type can hold against drainage by gravity. Field studies by Olson and Meek (1980) indicated that Ps. columbiae egg deposition on rice field levees varied with vertical elevation above the surface of standing water.

In studying factors influencing the attractiveness of sites to ovipositing Ps. columbiae, it would be valuable to determine a more precise measurement of preferred soil moisture than those measures made in previous studies.

MATERIALS AND METHODS

Methods used were similar to those described by Knight and Baker (1962) and Russo (1977). Adult ♀ Ps. columbiae were trapped in Jefferson Davis Parish, LA using CDC light traps baited with dry ice. Mosquitoes were transferred from catch bags to 30 cm square screen cages covered with damp towels to insure high humidity. Cages contained from 75 to 219 mosquitoes. Soil moisture preference experiments were conducted in these cages. Soaked raisins covered with wet paper towels were kept on the cages at all times as a carbohydrate source. Mosquitoes were offered guinea pigs as blood meals 4 and 3 days prior to beginning the tests. Cages were kept in the laboratory at approximately 22°C and in a 12:12 light:dark cycle. Tests were conducted in early and mid-October.

The substrate used in these tests was Jeanerette silt loam soil from a rice field in Vermilion Parish, LA. This soil was screened through a 40 mesh sieve to remove vegetation and large pieces of detritus and then was dried to a constant weight in a 110°C oven. Even though oven-drying may alter the chemical composition of the soil (Strickman 1980), results obtained using oven-dried soil are more relevant to field conditions than gauze, cheesecloth or sand. Fifty g of dry soil were weighed in a 9 cm diameter plastic petri dish bottom. Approximately 1 h prior to beginning a test the appropriate amount of water was added to each dish to establish the desired % moisture by weight. Soil in petri dishes with lower % soil moisture was stirred with a metal spatula to insure equal distribution of moisture throughout the sample. During each trial mosquitoes were exposed to 6 soil moisture levels. The first series of trials involved soil at 0, 20, 40, 60 and 80% moisture by weight and a sixth petri dish containing only water. Three trials each involving 3 cages of mosquitoes were conducted with the first series of moisture levels. The second series of tests involved soil at 30, 40, 50, 60, 70 and 80% soil moisture by weight. These moisture levels were used in 2 trials of 4 cages each. The 6 petri dish bottoms containing soil were placed in random order in the cages.

Tests began approximately 1 h before sunset and ended 2 h after dawn. Previous unpublished data indicated that Ps. columbiae lays significantly more eggs at night than during the day. Petri dishes were reweighed after being taken from the cages. Weight changes in the soil due to evaporation or absorption (taking up moisture from the air) averaged 3.3%. Soil moisture levels did not overlap from the beginning to the end of the tests.

Eggs were recovered from soil samples using techniques described by Horsfall (1956). Collapsed eggs were not counted as they would have been in the soil prior to testing.

Transformed data from the tests were subjected to an analysis of variance using SAS general linear model procedure to test the hypothesis that the mean numbers of eggs deposited at different soil moisture levels were equal. To equalize variances, data were transformed by adding 1 to each number and taking the natural logarithm of the resulting number. Following rejection of the hypothesis, orthogonal contrasts were conducted to test for linear, quadratic, cubic and quartic effects.

RESULTS AND DISCUSSION

Eggs were laid on soil at all moisture levels. Analysis of variance on data from the first series of tests in which 0, 20, 40, 60, 80 and 100% soil moisture levels were presented to mosquitoes indicated that mean numbers of eggs laid at different levels were significantly different ($P<.004$). Orthogonal contrasts revealed that there was a significant quadratic effect ($P<.001$). Data from this experiment are illustrated in Figure 1. During the 9 trials an

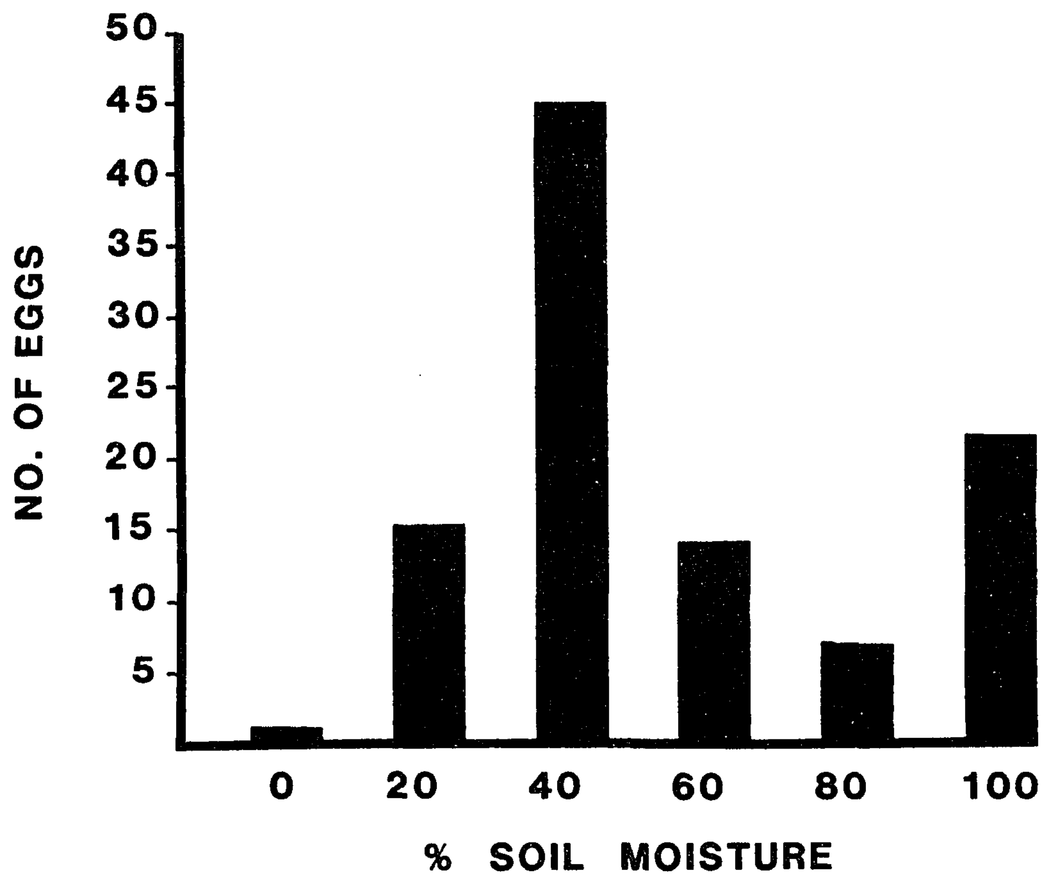

Figure 1. Psorophora columbiae eggs deposited at soil moisture levels ranging from 0% to 100%.

average of 2.2 eggs were laid at the 0% moisture level. This is the moisture level at which the fewest eggs were deposited on the average. On the other hand, the 40% moisture level received the most eggs with a mean of 89.8 eggs/trial. At 20, 60 and 80% moisture levels averages of 30.2, 28.3 and 14.0 eggs/trial respectively were deposited. Surprisingly, an average of 43.2 eggs/trial were laid in petri dishes containing water.

Eggs were also deposited at all soil moisture levels in the second series of tests in which dishes containing soil at 30, 40, 50, 60, 70 and 80% moisture levels were presented to mosquitoes. The mean numbers of eggs laid at different soil moistures were significantly different ($P<.008$). There was a significant linear effect ($P<.001$). Data are illustrated in Figure 2. Mean numbers of eggs/trial laid at 30, 40 and 50% moisture levels were 125.8, 188.6 and 176.9 respectively. Lower numbers of eggs were deposited at 60, 70 and 80% soil moistures with 39.6, 46.3 and 31.5 eggs/trial respectively.

Olson and Meek (1977) conducted laboratory experiments in which the majority of _Ps. columbiae_ eggs were deposited on soil whose moisture content ranged between 75% field capacity to just above field capacity. The soil used in this experiment was a heavy clay soil from Brazoria County, TX. We found that silt loam soil containing 30% moisture by weight fit within the 75% field capacity to just above field capacity category. In the experiment described herein most eggs were deposited in the 30 to 50% soil moisture range with the highest average number of eggs being deposited at 40% soil

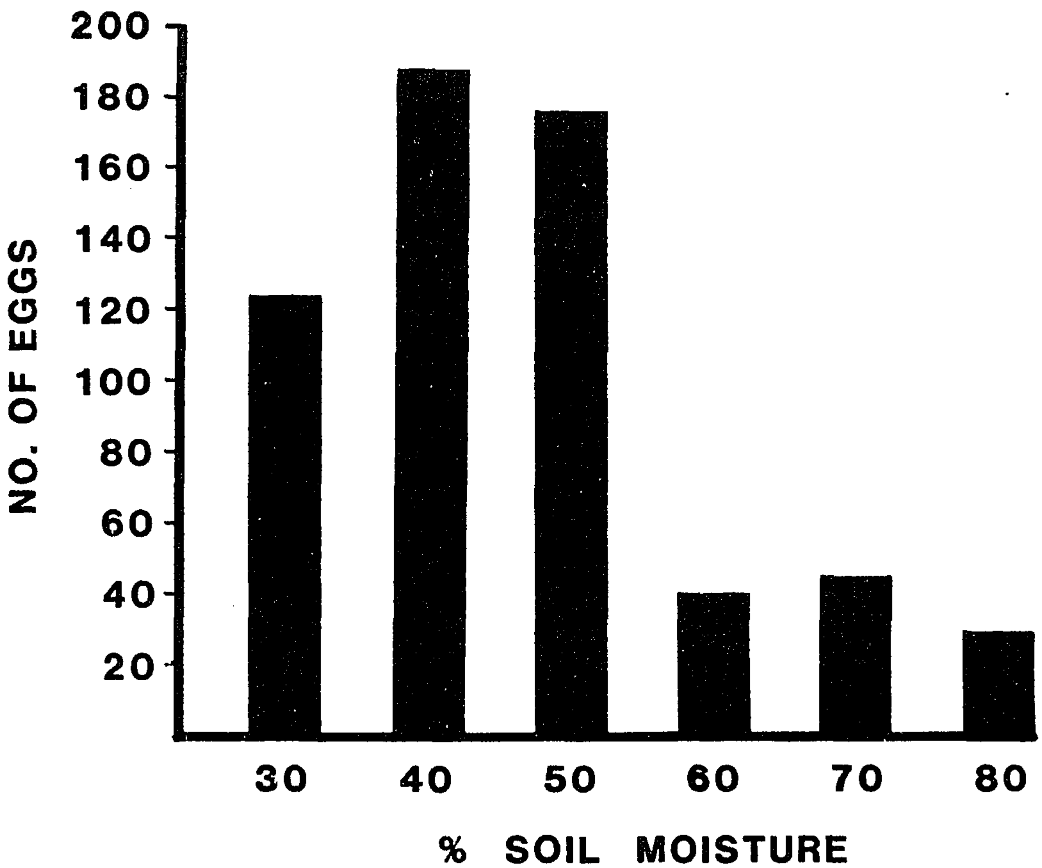

Figure 2. Psorophora columbiae eggs deposited at soil moisture levels ranging from 30% to 80%.

moisture in both series of tests. More work should be conducted to determine if the moisture preferences demonstrated in this study are relevant to those expressed by ovipositing *Ps. columbiae* under field conditions.

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CONCLUDING REMARKS

The results of these studies indicate that both fallow rice fields used as pastures and permanent pastures are important oviposition sites for *Ps. columbiae* in the riceland areas of Louisiana. Since the results of these studies are presented in terms of eggs/hoofprint or eggs and egg capsules/hoofprint, then the numbers cannot be said to represent the mosquito productivity of these pastures. Further studies should be conducted to enable an estimate of egg density to be translated to an estimate of potential mosquitoes. Emergence studies on flooded pasture sites may give some idea of what percentage of eggs develop into adult mosquitoes. These types of studies may also assess the importance of predators in hoofprints, particularly the predaceous mosquito larvae of *Ps. ciliata*, as sources of larval mortality.

Although cattle movement was not found to influence egg distribution in this study, it is the author's opinion that the effect of the presence or absence of cattle at pasture sites on mosquito egg abundance deserves further study. Cattle movement may influence egg distribution in pastures of larger size than those studied. It would also be valuable to study the effect of the presence and subsequent absence of cattle on egg abundance in adjacent rice field oviposition sites.

Egg distribution was not influenced by hoofprint depth or hoofprint density in this study. If further studies are conducted on egg distribution within pasture sites, attention should be given to quantifying soil moisture and mapping vegetation zones.

Correlation between either of these factors and mosquito egg distribution would greatly aid in mapping potential breeding areas.

Peak oviposition by Ps. columbiae in laboratory tests occurred soon after sunset. If these results are substantiated in field experiments, then even more credence is given to the evening timing of spraying by mosquito abatement districts.

Moisture preference experiments conducted with ovipositing Ps. columbiae revealed a fairly wide range of acceptable soil moisture levels. Additional laboratory experiments should be designed to test the influence of vegetation on oviposition site choice and to test the attractiveness to ovipositing Ps. columbiae of different depth depressions as compared to flat soil surfaces. These laboratory results should be related to oviposition as it occurs in the field. A repetition of moisture preference tests should be conducted to determine if oviposition in standing water occurs regularly.

APPENDIX

Appendix Table 1. Eggs and capsules of Ps. columbiae recovered from hoofprint samples and hoofprint density recorded from a permanent pasture in Vermilion Parish, LA. during 1980.

Date	Section Number	Eggs and capsules/hoofprint sample: Sample Number 1	2	3	4	5	6	7	8	9	10	Hoofprints/m^2: Sample Number 1	2	3	4
Feb. 26	1	1	1	0	0	0	0	0	1	0	0	1	0	3	3
	2	3	0	0	8	1	1	1	0	2	0	0	23	0	3
	3	0	0	1	0	0	2	1	0	1	0	23	1	0	27
	4	2	1	0	0	0	1	0	1	0	3	1	0	3	1
	5	0	7	0	2	0	18	1	0	-	29	13	9	3	9
	6	3	0	0	0	0	0	0	1	0	0	1	0	0	2
April 18	1	2	0	0	9	2	3	0	2	4	0	0	8	13	5
	2	0	1	1	0	1	2	-	1	1	0	10	9	18	7
	3	0	1	3	5	4	5	2	3	0	3	14	0	0	7
	4	0	0	0	2	6	1	0	0	0	0	0	16	22	2
	5	0	50	8	0	0	0	0	0	14	0	6	2	13	0
	6	1	0	0	1	1	1	3	0	0	0	0	0	0	0
29	1	0	3	0	0	1	0	1	0	2	2	0	1	9	0
	2	1	7	0	121	2	25	31	3	10	2	1	1	2	8
	3	20	24	2	2	10	0	-	9	4	52	12	1	0	3
	4	0	8	3	-	0	31	0	0	5	6	7	1	4	0
	5	21	29	19	6	6	29	36	161	22	12	2	0	4	7
	6	-	5	0	3	17	6	12	0	9	8	0	6	0	0
May 8	1	1	2	2	2	8	16	13	14	0	0	5	0	11	0
	2	0	0	0	0	3	2	1	2	13	0	1	0	6	2
	3	0	19	3	1	34	33	1	34	0	0	0	6	0	10
	4	3	3	2	8	4	3	25	18	0	1	0	11	3	1
	5	59	20	1	17	67	32	16	0	31	11	10	3	8	3
	6	11	2	2	1	0	7	0	0	2	1	1	16	0	0

Appendix Table 1. (continued)

Date		Section Number	Eggs and capsules/hoofprint sample										Hoofprints/m^2			
			Sample Number										Sample Number			
			1	2	3	4	5	6	7	8	9	10	1	2	3	4
May	26	1	1	0	0	2	0	0	0	1	3	2	1	3	2	1
		2	1	-	0	1	2	0	2	5	1	0	3	0	4	3
		3	0	0	1	0	0	0	4	3	0	3	9	1	1	2
		4	2	0	0	59	11	24	1	1	1	4	4	0	9	0
		5	2	6	0	3	3	0	3	1	2	0	5	3	15	4
		6	1	0	0	3	4	0	0	0	1	0	0	12	0	0
June	2	1	0	1	1	0	0	1	0	-	46	2	7	5	5	0
		2	0	0	2	14	1	40	67	3	154	84	0	0	2	6
		3	0	0	14	4	13	6	8	34	23	1	12	5	1	9
		4	0	1	0	10	24	7	2	15	22	9	0	7	3	7
		5	37	4	107	10	62	0	0	21	7	1	1	2	8	4
		6	0	0	1	-	3	0	1	0	0	4	1	7	0	0
	9	1	0	0	1	0	0	1	1	5	0	29	2	8	8	0
		2	0	0	0	0	25	0	1	19	7	0	0	1	0	4
		3	0	0	16	0	2	16	49	8	1	3	10	2	0	3
		4	0	0	0	0	0	32	0	0	1	125	5	5	0	0
		5	0	2	18	59	97	3	161	8	0	28	3	0	0	1
		6	0	0	0	1	0	0	0	0	1	0	6	0	0	0
	16	1	11	7	2	1	0	0	0	0	31	0	2	1	7	0
		2	0	0	4	0	-	0	6	3	0	1	1	1	4	0
		3	0	2	3	7	17	1	297	14	34	25	7	0	2	4
		4	0	1	5	0	5	10	78	19	1	47	1	0	1	0
		5	32	33	3	1	59	3	32	0	13	0	3	2	5	1
		6	3	3	2	6	3	9	0	1	0	0	3	5	0	0
June	24	1	13	0	18	0	0	-	5	4	2	9	1	0	4	0
		2	0	0	5	32	34	0	23	0	-	1	2	1	2	2

Appendix Table 1. (continued)

Date	Section Number	Eggs and capsules/hoofprint sample										Hoofprints/m^2			
		Sample Number										Sample Number			
		1	2	3	4	5	6	7	8	9	10	1	2	3	4
	3	0	0	0	0	7	5	23	2	1	53	7	0	0	3
	4	0	1	5	0	5	10	78	19	1	47	0	1	1	0
	5	21	5	31	0	1	0	61	4	14	40	0	2	1	3
	6	40	-	1	0	0	5	2	12	1	1	0	1	0	0
30	1	0	0	0	0	0	0	0	-	2	16	1	3	4	0
	2	24	18	2	2	0	3	13	15	0	16	9	0	0	4
	3	0	1	1	-	10	41	3	6	30	15	2	0	0	0
	4	0	0	0	11	4	2	0	48	0	0	0	7	6	3
	5	0	0	15	10	0	9	10	13	17	5	4	3	3	0
	6	17	23	0	1	15	1	3	1	2	1	2	0	0	0
July 7	1	0	2	0	0	2	1	0	0	0	1	1	4	5	3
	2	0	4	0	0	0	1	0	0	1	0	1	0	6	0
	3	4	0	2	0	1	130	8	3	0	2	7	1	0	1
	4	0	0	0	0	10	6	2	0	6	31	3	1	0	3
	5	40	3	16	31	26	6	0	12	1	1	3	0	0	3
	6	2	1	0	0	0	0	0	0	0	0	2	0	0	0
14	1	0	2	0	0	0	3	0	9	1	0	2	2	0	3
	2	0	0	0	0	2	0	0	1	3	18	1	0	1	1
	3	1	0	3	14	0	3	184	1	0	1	6	1	1	2
	4	0	0	2	0	0	0	10	6	0	1	2	4	0	0
	5	22	5	26	2	28	2	138	64	0	1	3	0	0	0
	6	6	2	31	3	13	0	0	0	0	1	0	2	0	0
21	1	30	0	0	10	1	0	0	20	0	24	0	3	1	1
	2	0	0	2	1	9	11	3	1	19	213	0	0	2	1
	3	1	10	1	2	0	3	2	3	0	14	4	0	4	0
	4	0	0	1	0	1	2	0	27	0	0	0	0	2	3

Appendix Table 1. (continued)

Date	Section Number	Eggs and capsules/hoofprint sample — Sample Number 1	2	3	4	5	6	7	8	9	10	Hoofprints/m^2 — Sample Number 1	2	3	4
	5	24	18	93	6	0	17	13	0	80	7	0	1	4	1
	6	0	2	1	0	3	10	3	1	2	1	3	2	1	1
31	1	0	0	1	0	0	0	0	1	3	17	0	3	1	5
	2	1	2	6	0	2	0	1	53	6	0	0	0	0	0
	3	0	0	0	111	1	3	33	10	0	0	5	0	5	0
	4	0	3	17	0	0	14	16	0	6	0	1	2	1	3
	5	29	5	71	0	0	57	68	138	5	5	0	2	1	0
	6	2	0	0	2	1	1	0	0	1	7	0	0	1	0

Appendix Table 2: Totals of the numbers of cattle observed every 3 h for 5 24 h periods in 6 sections of a permanent pasture in Vermilion Parish, LA during 1980.

Date		Cattle Observed Over 24 h per Pasture Section Pasture section number					
		1	2	3	4	5	6
June 8		75	638	93	62	124	0
July 9		124	248	146	325	9	141
10		124	248	0	248	133	239
16		191	57	477	19	248	0
17		8	4	263	106	487	124
	TOTAL	522	1195	979	760	1001	504

Appendix Table 3: Adult mosquito collections from a permanent pasture in Vermilion Parish, LA during 1980 collected by CDC light trap baited with dry ice.

	DATES OF COLLECTION																
	MAR	APRIL					MAY	JUNE					JULY				AUG
	11	2	10	16	18	29	26	2	9	16	24	30	7	14	21	31	6
Cx. salinarius	20	51	392	212	22	2	8,344	1,152	5,152	49,104	5,500	1,292	7,208	202	135	1,208	35
Ps. columbiae			43	2	5		7,208	3,944	14,720	34,892	6,244	2.084	10,520	2,806	291	16,880	97
An. crucians					1	1	316	1,836	3,200	6,928	5,360	1,138	3,816	1,080	8	544	35
Ae. vexans			4	1	1		296		80	96	28	10	56	14	2	408	6
Ae. sollicitans				1	1		216	28		128	4	4				104	
Ps. ciliata							52	16	32	112	44	4	16	8		40	
Cq. perturbans				7			144		16		12	8	8	8		16	
Cx. erraticus									32		44	34	288	60	29	216	19
An. quadrimaculatus								4	32	96	460	2	112	22	2	8	
Cx. p. quinquefasciatus															2		
Ur. sapphirina																8	
TOTAL	20	51	439	233	30	3	16,576	6,980	23,264	91,344	17,696	4,576	22,024	4,200	469	19,432	202

Appendix Table 4: Analysis of variance procedure for *Psorophora columbiae* eggs and capsules collected from hoofprints taken from a pasture in Vermilion Parish, LA during 1980.

Source	df	Sum of squares	Mean squares	F value	PR>F
Section of pasture	5	30154.8962	6030.9792	11.38	0.0001
Sampling date	13	15049.7460	1157.6728	2.19	0.0088
Section X date	65	37734.6870	580.5336	1.11	0.2602
Error	742	387178.0667	521.8033		

Appendix Table 5: Duncan's multiple range test for the average number of *Psorophora columbiae* eggs and capsules/hoofprint/section of a permanent pasture in Vermilion Parish, LA during 1980.

Section	N	$\bar{X}$ of eggs and capsules/hoofprint	Duncan grouping*
5	139	20.6	A
3	138	11.9	B
2	136	9.1	B
4	139	7.5	B C
1	137	3.2	C
6	137	2.7	C

*Means with the same letter are not significantly different.

Appendix Table 6: Eggs and capsules of <u>Ps</u>. <u>columbiae</u> recovered from hoofprint samples and hoofprint density and hoofprint depth recorded for hoofprint samples from a permanent pasture in Vermilion Parish, LA during 1981.

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
May 15	1	3	12	-	-
	2	0	0	3	-
	3	1	3	-	-
	4	2	6	6	-
	5	0	2	-	-
	6	1	12	-	-
	7	1	2	8	-
	8	9	116	-	-
	9	6	9	5	-
	10	13	6	-	-
	11	67	87	-	-
	12	4	6	6	-
	13	2	12	-	-
	14	0	1	8	-
	15	11	29	-	-
	16	0	3	-	-
	17	1	3	9	-
	18	0	1	-	-
	19	2	8	8	-
	20	1	1	-	-
	21	1	0	-	-
	22	0	4	5	-
	23	0	3	-	-
	24	3	4	4	-
	25	24	17	-	-
	26	1	12	-	-
	27	14	58	7	-
	28	3	4	-	-
	29	2	2	6	-
	30	2	0	-	-
May 20	1	17	1	-	-
	2	0	1	7	-
	3	83	24	-	-
	4	23	2	7	-
	5	0	1	-	-
	6	1	0	-	-
	7	0	1	5	-
	8	2	2	-	-
	9	6	4	4	-
	10	1	0	-	-

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	11	1	1	-	-
	12	15	2	7	-
	13	2	11	-	-
	14	1	0	5	-
	15	13	7	-	-
	16	1	0	-	-
	17	1	0	2	-
	18	0	1	-	-
	19	1	0	3	-
	20	0	1	-	-
	21	29	42	-	-
	22	0	0	3	-
	23	3	1	-	-
	24	0	0	5	-
	25	8	1	-	-
	26	0	1	-	-
	27	1	0	7	-
	28	1	17	-	-
	29	7	2	4	-
	30	0	0	-	-
May 26	1	0	1	-	-
	2	0	0	7	-
	3	0	0	-	-
	4	0	0	6	-
	5	5	0	-	-
	6	0	3	-	-
	7	0	0	4	-
	8	0	0	-	-
	9	2	38	10	-
	10	1	6	-	-
	11	0	0	-	-
	12	2	0	9	-
	13	9	0	-	-
	14	1	0	11	-
	15	0	1	-	-
	16	1	3	-	-
	17	0	0	8	-
	18	0	0	-	-
	19	5	0	10	-
	20	0	5	-	-
	21	4	0	-	-
	22	1	0	7	-
	23	0	0	-	-
	24	0	2	7	-

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	25	0	1	-	-
	26	16	64	-	-
	27	10	3	6	-
	28	0	0	-	-
	29	2	5	9	-
	30	0	0	-	-
June 2	1	0	0	-	-
	2	0	0	5	-
	3	3	5	-	-
	4	1	0	4	-
	5	0	0	-	-
	6	3	0	-	-
	7	0	0	10	-
	8	9	2	-	-
	9	1	1	3	-
	10	0	1	-	-
	11	2	2	-	-
	12	12	10	8	-
	13	0	6	-	-
	14	9	6	7	-
	15	0	0	-	-
	16	0	2	-	-
	17	22	4	6	-
	18	3	3	-	-
	19	1	0	5	-
	20	3	2	-	-
	21	0	2	-	-
	22	0	0	5	-
	23	0	1	-	-
	24	6	5	12	-
	25	2	0	-	-
	26	1	0	-	-
	27	1	6	9	-
	28	1	3	-	-
	29	2	0	8	-
	30	0	2	-	-
June 18	1	0	0	3	-
	2	0	0	5	-
	3	0	0	7	-
	4	0	4	2	-
	5	0	0	5	-
	6	0	0	3	-
	7	3	2	6	-

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	8	9	5	3	-
	9	11	25	4	-
	10	0	0	5	-
	11	5	3	6	-
	12	2	0	4	-
	13	2	2	4	-
	14	0	0	6	-
	15	0	0	5	-
	16	0	0	6	-
	17	0	1	8	-
	18	0	4	5	-
	19	1	0	4	-
	20	0	0	7	-
	21	2	5	7	-
	22	0	5	4	-
	23	3	0	7	-
	24	17	10	6	-
	25	8	8	5	-
	26	1	1	7	-
	27	0	0	5	-
	28	0	0	6	-
	29	0	0	4	-
	30	1	1	3	-
July 13	1	2	21	3	3.5
	2	0	0	1	2.0
	3	0	0	5	2.8
	4	0	0	1	2.8
	5	8	11	8	5.0
	6	28	11	3	5.0
	7	3	0	5	3.8
	8	3	8	5	4.0
	9	0	1	6	3.0
	10	1	0	5	2.0
	11	5	11	4	2.0
	12	1	1	6	3.0
	13	1	1	4	2.3
	14	0	0	6	2.5
	15	0	3	3	3.5
	16	0	4	3	4.0
	17	1	0	3	3.5
	18	1	0	5	5.0
	19	1	6	4	6.5
	20	0	3	2	4.8
	21	1	1	3	3.0

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	22	5	1	6	4.5
	23	0	0	2	3.0
	24	0	0	4	3.5
	25	6	6	4	4.5
	26	0	0	5	2.0
	27	0	0	4	5.0
	28	1	1	2	6.0
	29	0	1	2	2.5
	30	3	1	4	3.5
July 21	1	5	2	4	2.5
	2	2	0	7	3.0
	3	0	0	4	3.0
	4	2	3	4	3.0
	5	0	0	3	2.5
	6	0	2	6	3.5
	7	2	1	8	4.5
	8	4	3	5	3.0
	9	1	0	8	4.5
	10	2	2	6	4.0
	11	0	1	4	3.5
	12	1	0	4	3.0
	13	1	4	2	2.0
	14	2	3	8	3.5
	15	2	2	7	3.0
	16	1	2	6	3.0
	17	0	0	4	4.5
	18	1	0	6	2.5
	19	3	4	7	4.5
	20	-	-	10	3.5
	21	0	0	14	3.0
	22	0	0	5	4.5
	23	4	2	6	3.0
	24	1	1	6	3.0
	25	0	0	4	3.0
	26	1	0	9	5.0
	27	0	2	3	2.5
	28	5	3	4	6.5
	29	0	2	5	7.0
	30	5	1	5	5.5
August 3	1	2	8	4	2.5
	2	6	2	5	3.0
	3	7	24	4	2.5
	4	6	0	2	3.5

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	5	0	1	3	3.0
	6	4	0	2	3.0
	7	0	3	5	2.0
	8	1	3	6	4.0
	9	1	2	5	3.0
	10	1	1	5	2.5
	11	0	1	4	3.0
	12	1	1	3	3.5
	13	6	0	1	2.0
	14	6	3	5	2.5
	15	8	5	9	2.5
	16	0	0	3	3.5
	17	1	0	8	2.5
	18	0	3	7	4.5
	19	1	3	9	5.0
	20	0	8	2	4.0
	21	0	0	8	3.0
	22	0	0	3	3.5
	23	8	2	3	3.0
	24	0	1	6	2.0
	25	2	0	3	4.0
	26	0	1	5	2.0
	27	4	1	3	3.0
	28	0	2	6	3.0
	29	39	16	4	3.5
	30	3	3	6	3.0
August 12	1	22	2	2	2.5
	2	0	2	4	3.0
	3	1	0	2	3.0
	4	2	1	5	2.0
	5	8	2	3	5.0
	6	1	0	5	3.5
	7	0	0	5	3.0
	8	0	0	4	2.5
	9	0	0	2	3.0
	10	0	3	3	2.0
	11	0	3	2	2.0
	12	1	3	4	4.0
	13	0	2	5	2.5
	14	6	5	5	2.0
	15	9	8	6	3.0
	16	0	0	5	2.5
	17	0	0	7	3.0
	18	0	0	6	3.0

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	19	0	2	3	4.0
	20	5	0	5	2.0
	21	0	1	4	4.0
	22	2	1	5	3.5
	23	0	2	3	3.0
	24	2	1	4	2.0
	25	1	0	2	3.0
	26	0	0	6	2.5
	27	5	4	6	4.0
	28	0	0	4	2.0
	29	2	2	7	4.0
	30	15	16	4	4.0
August 27	1	2	2	2	3.0
	2	0	1	0	3.0
	3	2	1	3	2.5
	4	0	4	2	2.5
	5	0	0	9	4.0
	6	22	18	6	2.0
	7	0	0	3	3.0
	8	3	0	3	2.0
	9	1	0	2	3.0
	10	0	2	3	3.5
	11	2	6	2	2.0
	12	0	1	4	2.0
	13	0	1	1	2.0
	14	0	1	4	3.5
	15	5	7	2	3.0
	16	1	4	6	6.0
	17	5	10	5	5.0
	18	1	1	4	4.0
	19	0	0	4	4.0
	20	0	26	6	4.0
	21	7	7	6	3.5
	22	1	2	2	2.5
	23	3	1	4	3.0
	24	14	10	8	3.5
	25	16	6	3	3.0
	26	3	14	4	3.5
	27	1	1	5	3.5
	28	3	2	3	2.5
	29	3	12	3	3.0
	30	0	0	5	2.5
Sept. 3	1	1	3	1	5.0

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	2	7	1	2	4.0
	3	23	6	3	3.5
	4	1	0	2	4.5
	5	0	0	1	3.0
	6	1	0	1	3.5
	7	0	1	3	4.0
	8	1	0	2	3.0
	9	2	0	2	4.0
	10	2	3	2	3.5
	11	3	0	3	2.5
	12	0	3	2	3.5
	13	11	0	4	2.5
	14	6	21	3	3.0
	15	3	17	5	3.0
	16	0	2	4	3.0
	17	0	1	6	4.0
	18	8	4	7	4.0
	19	3	2	3	3.5
	20	1	1	2	2.5
	21	1	2	1	4.0
	22	2	5	2	3.0
	23	0	1	2	3.5
	24	1	2	2	2.5
	25	8	16	3	3.5
	26	27	91	2	5.0
	27	0	0	3	2.5
	28	4	16	2	3.0
	29	0	0	4	3.0
	30	4	8	5	5.5
Sept. 15	1	0	2	2	3.0
	2	2	1	2	3.5
	3	0	1	3	4.0
	4	0	2	1	2.5
	5	0	1	1	4.0
	6	0	1	0	3.5
	7	1	8	2	4.5
	8	2	11	4	3.0
	9	4	16	6	6.0
	10	0	2	3	3.5
	11	1	0	2	4.0
	12	1	12	1	4.5
	13	1	6	1	2.5
	14	9	2	3	5.0
	15	2	1	1	2.5

Appendix Table 6: (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)
	16	0	0	1	4.0
	17	1	15	2	5.0
	18	3	1	1	3.5
	19	1	4	3	2.5
	20	1	1	3	3.5
	21	1	1	4	4.0
	22	2	0	1	3.0
	23	6	3	1	2.5
	24	0	3	2	3.0
	25	1	1	2	2.5
	26	0	0	1	2.0
	27	1	5	2	2.5
	28	1	0	1	3.0
	29	0	2	3	3.0
	30	1	0	2	3.0

Appendix Table 7. Eggs and capsules of Ps. columbiae recovered from hoofprint samples and hoofprint density, hoofprint depth, and hoofprint location recorded for hoofprint samples from a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1]
May 15	1	0	4	-	-	-
	2	0	16	3	-	-
	3	2	5	-	-	-
	4	0	4	6	-	-
	5	3	2	-	-	-
	6	1	1	-	-	-
	7	0	0	8	-	-
	8	0	0	-	-	-
	9	2	5	5	-	-
	10	2	9	-	-	-
	11	2	4	-	-	-
	12	0	0	6	-	-
	13	1	1	-	-	-
	14	0	2	8	-	-
	15	1	1	-	-	-
	16	2	3	-	-	-
	17	3	18	9	-	-
	18	0	21	-	-	-
	19	0	45	8	-	-
	20	2	6	-	-	-
	21	2	7	-	-	-
	22	0	0	5	-	-
	23	0	0	-	-	-
	24	1	0	4	-	-
	25	1	1	-	-	-

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	26	2	7	-	-	-
	27	0	1	7	-	-
	28	1	3	-	-	-
	29	0	8	6	-	-
	30	2	2	-	-	-
May 20	1	0	0	-	-	-
	2	1	1	5	-	-
	3	0	0	-	-	-
	4	1	5	12	-	-
	5	1	3	-	-	-
	6	1	0	-	-	-
	7	0	0	11	-	-
	8	0	2	-	-	-
	9	2	2	11	-	-
	10	0	0	-	-	-
	11	0	0	-	-	-
	12	0	1	3	-	-
	13	1	1	-	-	-
	14	0	14	2	-	-
	15	9	6	-	-	-
	16	1	0	-	-	-
	17	32	34	12	-	-
	18	3	5	-	-	-
	19	3	20	8	-	-
	20	1	2	-	-	-
	21	1	1	-	-	-
	22	0	4	7	-	-

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	23	0	1	–	–	–
	24	2	1	8	–	–
	25	2	0	–	–	–
	26	0	0	–	–	–
	27	0	3	4	–	–
	28	1	2	–	–	–
	29	4	3	5	–	–
	30	1	1	–	–	–
May 26	1	0	0	–	–	–
	2	1	17	6	–	–
	3	1	1	–	–	–
	4	0	0	11	–	–
	5	0	1	–	–	–
	6	0	1	–	–	–
	7	0	0	12	–	–
	8	0	1	–	–	–
	9	1	0	11	–	–
	10	0	1	–	–	–
	11	1	1	–	–	–
	12	0	2	7	–	–
	13	0	1	–	–	–
	14	0	0	10	–	–
	15	1	0	–	–	–
	16	0	2	–	–	–
	17	4	7	13	–	–
	18	0	1	–	–	–
	19	0	1	9	–	–

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location 1/
	20	0	0	-	-	-
	21	0	1	-	-	-
	22	4	0	11	-	-
	23	0	2	-	-	-
	24	0	0	14	-	-
	25	2	0	-	-	-
	26	1	2	-	-	-
	27	0	0	10	-	-
	28	1	0	-	-	-
	29	0	0	8	-	-
	30	1	0	-	-	-
June 2	1	0	0	-	-	-
	2	2	11	10	-	-
	3	3	0	-	-	-
	4	2	2	11	-	-
	5	0	0	-	-	-
	6	0	0	-	-	-
	7	0	3	10	-	-
	8	0	0	-	-	-
	9	3	2	7	-	-
	10	1	7	-	-	-
	11	0	4	-	-	-
	12	0	0	3	-	-
	13	0	7	-	-	-
	14	1	3	2	-	-
	15	2	18	-	-	-
	16	4	1	-	-	-

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location 1/
	17	0	3	10	-	-
	18	13	9	-	-	-
	19	0	3	9	-	-
	20	1	3	-	-	-
	21	0	1	-	-	-
	22	1	0	10	-	-
	23	4	2	-	-	-
	24	0	3	11	-	-
	25	1	1	-	-	-
	26	2	1	-	-	-
	27	1	2	8	-	-
	28	0	0	-	-	-
	29	15	9	7	-	-
	30	2	27	-	-	-
June 18	1	1	1	1	-	L
	2	0	0	6	-	S
	3	1	2	6	-	M
	4	2	5	2	-	S
	5	0	4	5	-	L
	6	0	0	8	-	L
	7	0	0	2	-	L
	8	-	-	-	-	-
	9	-	-	-	-	-
	10	-	-	-	-	-
	11	1	14	8	-	L
	12	2	21	0	-	S
	13	0	1	1	-	M

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	14	0	5	2	-	S
	15	0	2	2	-	L
	16	1	1	6	-	L
	17	3	10	5	-	S
	18	15	17	5	-	M
	19	1	2	3	-	S
	20	0	3	3	-	L
	21	-	-	-	-	-
	22	-	-	-	-	-
	23	-	-	-	-	-
	24	-	-	-	-	-
	25	-	-	-	-	-
	26	1	0	6	-	L
	27	0	0	4	-	S
	28	2	5	10	-	M
	29	-	-	-	-	-
	30	1	6	3	-	L
July 21	1	3	34	1	4.0	M
	2	2	7	3	5.0	S
	3	0	1	12	6.0	L
	4	9	11	9	3.0	S
	5	2	3	10	7.0	L
	6	6	3	12	11.0	M
	7	6	4	15	10.0	S
	8	0	0	6	6.0	L
	9	0	2	12	6.5	L
	10	0	1	9	9.0	S

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	11	1	2	10	9.5	M
	12	1	2	12	6.5	S
	13	2	3	6	5.0	L
	14	1	1	3	6.0	L
	15	0	1	2	4.0	S
	16	1	3	0	5.0	M
	17	1	1	10	6.0	S
	18	0	5	8	5.0	L
	19	2	9	10	5.5	L
	20	0	0	11	6.0	S
	21	0	0	9	5.0	M
	22	2	3	7	5.5	S
	23	1	0	9	7.0	L
	24	2	0	10	8.0	L
	25	0	0	14	6.5	S
	26	1	0	11	6.0	L
	27	0	2	7	8.0	S
	28	3	2	11	8.0	M
	29	-	-	13	7.0	S
	30	0	1	9	6.0	L
August 3	1	19	6	11	6.5	L
	2	1	2	7	6.5	S
	3	0	2	1	2.5	M
	4	0	0	1	4.0	S
	5	0	0	6	3.0	L
	6	2	2	7	3.0	M
	7	2	1	9	6.0	S

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	8	2	5	8	3.0	L
	9	0	1	14	4.0	L
	10	4	2	8	5.5	S
	11	0	1	10	5.0	S
	12	2	1	4	1.5	L
	13	4	9	10	5.5	L
	14	3	8	4	4.5	S
	15	1	4	6	4.5	M
	16	0	0	7	2.5	M
	17	5	0	8	3.0	S
	18	0	3	5	3.5	L
	19	22	7	10	6.0	L
	20	2	2	9	8.5	S
	21	1	4	7	4.0	S
	22	1	2	7	7.0	L
	23	0	2	9	8.0	L
	24	1	1	8	7.0	S
	25	2	0	9	6.5	M
	26	16	1	11	5.5	L
	27	1	2	8	4.0	S
	28	3	0	8	4.5	M
	29	1	1	9	7.5	S
	30	8	4	8	5.5	L
August 12	1	1	3	6	3.5	L
	2	8	3	10	4.5	S
	3	2	6	7	4.0	M
	4	1	4	8	2.5	S

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	5	0	0	6	5.0	L
	6	2	6	9	5.0	S
	7	1	0	5	3.0	L
	8	16	3	10	7.5	L
	9	2	2	6	5.5	S
	10	1	6	10	6.0	M
	11	1	5	8	8.0	M
	12	0	5	7	6.5	S
	13	1	2	6	3.0	L
	14	0	1	4	3.0	L
	15	1	8	0	3.0	S
	16	2	13	3	2.5	M
	17	0	2	2	2.0	S
	18	0	0	4	2.5	L
	19	1	3	6	4.5	L
	20	0	5	4	3.0	S
	21	1	0	9	7.5	M
	22	2	0	11	5.5	S
	23	3	2	10	6.0	L
	24	21	1	10	5.0	L
	25	1	2	11	4.5	S
	26	0	3	8	5.0	L
	27	26	10	6	6.5	S
	28	4	3	8	5.0	M
	29	1	0	13	9.0	S
	30	1	0	11	4.0	L
August 27	1	0	1	7	4.0	L

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	2	2	3	3	3.5	S
	3	0	1	5	4.5	M
	4	1	10	6	5.0	S
	5	0	0	6	3.0	L
	6	0	0	2	5.0	S
	7	0	4	4	4.0	L
	8	0	0	3	5.0	L
	9	1	0	5	2.5	S
	10	0	4	5	6.0	M
	11	2	3	5	4.5	M
	12	0	2	6	4.5	S
	13	1	2	7	5.0	L
	14	0	2	5	2.5	L
	15	0	2	4	3.0	S
	16	0	6	5	4.0	S
	17	1	2	7	3.0	L
	18	0	0	6	6.5	L
	19	0	0	4	5.0	S
	20	2	0	4	4.0	M
	21	1	7	5	6.0	M
	22	3	1	3	5.0	S
	23	0	3	4	4.5	L
	24	0	1	3	5.0	L
	25	2	3	3	4.5	S
	26	0	0	3	4.5	L
	27	1	18	5	7.0	S
	28	1	1	9	7.5	M
	29	0	1	8	5.5	S

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	30	1	6	7	7.0	L
Sept. 3	1	0	0	2	4.0	M
	2	2	4	2	3.5	S
	3	4	14	1	5.5	L
	4	0	0	3	5.0	L
	5	10	13	3	3.0	S
	6	0	0	4	6.0	S
	7	0	3	4	7.0	L
	8	0	0	1	7.5	L
	9	0	1	2	4.0	S
	10	1	0	2	3.0	M
	11	0	1	5	9.0	M
	12	1	11	5	4.5	S
	13	6	3	7	8.0	L
	14	2	2	1	4.0	L
	15	3	20	0	3.5	S
	16	0	3	3	4.0	S
	17	0	5	5	7.0	L
	18	23	6	5	6.5	L
	19	2	1	3	6.0	S
	20	4	9	8	6.0	M
	21	1	8	4	6.0	M
	22	0	4	5	7.5	S
	23	1	2	6	6.0	L
	24	3	3	3	5.0	L
	25	0	1	4	3.5	S
	26	0	2	5	3.0	M

Appendix Table 7. (continued)

Date	Sample Number	Eggs/ hoofprint	Capsules/ hoofprint	Hoofprint density (m^2)	Hoofprint depth(cm)	Hoofprint location[1/]
	27	1	2	8	4.5	S
	28	0	1	7	3.0	L
	29	0	2	9	3.0	L
	30	2	2	10	2.5	S

[1/] Hoofprint location is abbreviated as follows:
1) "L" for hoofprints collected from the first 1 m of the borrow ditch next to the levee.
2) "S" for hoofprints collected within the first 11 m of the pan.
3) "M" for hoofprints collected from the middle of the pan.

Appendix Table 8: Totals of the numbers of cattle observed every 2 h for 7 24 h periods in 6 sections of a permanent pasture in Vermilion Parish, LA during 1981.

DATE		Cattle Observed Over 24 h per Pasture Section Pasture section number 1	2	3	4	5	6
May	20	0	10	0	18	30	110
	26	18	10	0	14	28	98
June	18	28	12	14	16	28	70
	29	22	14	6	14	23	89
July	13	19	14	9	0	56	70
	27	14	28	23	0	33	70
Aug.	12	8	6	0	14	56	84
TOTALS		110	96	55	80	259	597

Appendix Table 9: Adult mosquito collections from a permanent pasture in Vermilion Parish, LA during 1981 collected by CDC light trap with dry ice.

	Dates of Collection														
	MAY			June			July			August			Septmeber		
Species	15	20	26	2	18	24	29	13	21	27	3	12	1	8	17
Ps. columbiae	2032	360	3816	5888	680	318	4128	1216	1634	1688	5984	11992	579	5420	25
Cx. salinarius	916	2944	3536	10368	994	1264	6352	1242	1600	992	4696	8816	821	482	220
An. crucians	256	676	3006	3040	494	1476	3840	354	716	2120	1040	960	13	280	16
Ae. sollicitans	6560	276	240	320	486	42	512	142	30	8	9360	128	--	4	--
Ae. vexans	32	32	344	32	312	82	16	18	60	20	88	72	1	88	1
An. quadrimaculatus	8	100	464	928	28	62	432	6	42	244	64	64	1	-	2
Ps. ciliata	40	92	32	64	14	4	--	6	6	8	24	16	6	12	3
Cx. erraticus	--	--	--	--	2	12	16	4	20	20	--	8	5	--	--
others	--	--	8	--	--	2	--	10	--	--	--	--	3	--	--

Appendix Table 10: Adult mosquito collections from a fallow rice field used as pasture in Vermilion Parish, LA during 1981 collected by CDC light trap with dry ice.

	Dates of Collection													
	MAY		June			July			August			Septmeber		
Species	20	26	2	18	24	29	13	21	27	3	12	1	8	17
Ps. columbiae	178	2616	6560	748	188	1348	5144	4368	7248	1676	5188	3422	4848	600
Cx. salinarius	1500	7472	6608	3188	503	3744	7840	1776	2528	1752	7764	1156	1360	1173
An. crucians	96	920	1088	1148	520	604	928	1072	1120	6	476	48	348	204
Ae. sollicitans	78	96	32	520	26	24	200	--	8	318	8	--	4	--
Ae. vexans	4	40	16	224	21	--	--	--	56	6	72	44	32	6
An. quadrimaculatus	14	40	64	76	19	--	40	16	56	--	48	--	4	--
Ps. ciliata	6	--	16	4	1	4	72	--	--	30	51	162	4	2
Cx. erraticus	--	--	--	20	2	8	64	48	176	2	8	2	--	28
others	--	--	--	4	--	4	16	--	--	--	--	2	--	3

Appendix Table 11: Analysis of variance procedure for Psorophora columbiae eggs collected from hoofprints taken from a permanent pasture and a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
pasture type	1	434.1302	434.1302	11.24	0.0008
sampling date	12	800.7374	66.7281	1.73	0.0573
type x date	9	460.4727	51.1636	1.32	0.2197
error	626	24180.6128	38.6272		

Appendix Table 12: Analysis of variance procedure for Psorophora columbiae eggs and egg capsules collected from hoofprints taken from a permanent pasture and a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
pasture type	1	1033.3674	1033.3674	6.07	0.0140
sampling date	12	4679.5691	389.9641	2.29	0.0074
type x date	9	2905.3244	322.8138	1.90	0.0495
error	626	106570.3634	170.2402		

Appendix Table 13: Analysis of variance procedure for cattle hoofprint densities measured in a permanent pasture and a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
pasture type	1	218.6535	218.6535	41.02	0.0001
sampling date	12	1163.2018	96.9335	18.19	0.0001
type x date	9	222.3011	24.7001	4.63	0.0001
error	484	2579.6536	5.3299		

Appendix Table 14: Analysis of variance procedure for cattle hoofprint depths measured in a permanent pasture and a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
pasture type	1	291.0675	291.0675	169.43	0.0001
sampling date	7	66.2007	9.4572	5.51	0.0001
type x date	4	13.6367	3.4092	1.98	0.0964
error	347	596.1026	1.7179		

Appendix Table 15: Analysis of variance procedure for *Psorophora columbiae* egg densities recorded from a permanent pasture and a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
pasture type	1	845.6040	845.6040	0.91	0.3401
sampling date	12	23224.8334	1935.4028	2.09	0.0165
type x date	9	14066.2368	1562.9151	1.69	0.0892
error	482	446977.7989	927.3398		

Appendix Table 16: Analysis of variance procedure for the proportions of cattle hoofprints which contained either *Psorophora columbiae* eggs or egg capsules to those which contained neither recorded in a permanent pasture and a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
pasture type	1	0.000738	0.000738	3.93	0.0787
sampling date	12	0.005836	0.000486	2.59	0.0801
error	9	0.001689	0.000188		

Appendix Table 17: Analysis of variance procedure for <u>Psorophora columbiae</u> eggs/hoofprint from hoofprints taken at different locations[1/] in a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
hoofprint location	2	13.9783	6.9892	0.38	0.6826
sampling date	5	109.6803	21.9361	1.20	0.3107
location x date	10	232.0361	23.2036	1.27	0.2515
error	152	2774.9329	18.2561		

[1/] Hoofprints were taken from 3 locations: the first 1 m of the borrow ditch next to the levee, the first 11 m of the pan, and the middle of the pan.

Appendix Table 18. Analysis of variance procedure for <u>Psorophora columbiae</u> eggs and egg capsules/hoofprint from hoofprints taken at different locations[1/] in a fallow rice field used as pasture in Vermilion Parish, La during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
hoofprint location	2	48.6770	24.3385	0.49	0.6136
sampling date	5	213.2293	42.6459	0.86	0.5121
location x date	10	694.8236	69.4824	1.40	0.1857
error	152	7549.4649	49.6675		

[1/] Hoofprints were taken from 3 locations: the first 1 m of the borrow ditch next to the levee, the first 11 m of the pan, and the middle of the pan.

Appendix Table 19: Analysis of variance procedure for cattle hoofprint densities recorded at different locations[1/] in a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
hoofprint location	2	7.7077	3.8539	0.47	0.6263
sampling date	5	402.6184	80.5237	9.81	0.0001
location x date	10	51.1275	5.1128	0.62	0.7929
error	153	1256.3405	8.2114		

[1/] Hoofprints were taken from 3 locations: the first 1 m of the borrow ditch next to the levee, the first 11 m of the pan, and the middle of the pan.

Appendix Table 20: Analysis of variance procedure for cattle hoofprint depths recorded at different locations[1/] in a fallow rice field used as pasture in Vermilion Parish, LA during 1981.

Source	df	Sum of squares	Mean squares	F value	PR>F
hoofprint location	2	1.1025	0.5513	0.19	0.8284
sampling date	4	61.3438	15.3360	5.25	0.0006
location x date	8	27.7017	3.4627	1.18	0.3129
error	135	394.6458	2.9233		

[1/] Hoofprints were taken from 3 locations: the first 1 m of the borrow ditch next to the levee, the first 11 m of the pan, and the middle of the pan.

Appendix Table 21: Numbers of eggs laid by caged <u>Psorophora columbiae</u> per 2 h over a 24 h period beginning July 22, 1983.

Cage Number	Mosquitoes/ Cage	Time Period 1	2	3	4	5[1/]	6	7	8	9	10[2/]	11	12
1	8	2	4	1	38	16	64	51	44	8	7	3	1
2	7	13	5	6	1	57	38	37	78	16	2	18	5
3	7	1	5	0	0	1	3	1	36	6	5	0	1
4	5	71	17	12	33	78	39	73	68	29	15	6	3
5	10	25	10	2	17	105	12	9	9	75	6	2	6
6	13	11	8	10	5	9	37	17	159	15	3	5	8
7	8	18	3	15	21	47	81	18	26	113	6	5	2
8	12	10	1	9	10	299	11	41	4	4	2	0	4
9	4	51	19	13	7	193	24	53	2	12	1	1	3
10	10	20	15	18	3	35	63	35	19	25	3	2	1
11	7	9	4	11	2	1	1	0	1	0	2	0	0

1/ The beginning of period 5 coincided with sunset.
2/ Sunrise occurred approximately in the middle of period 10.

Appendix Table 22: Numbers of eggs laid by caged *Psorophora columbiae* per 2 h over a 24 h period beginning July 28, 1983.

Cage Number	Mosquitoes/ Cage	Time Period 1	2	3	4	5	6[1/]	7	8	9	10	11[2/]	12
1	11	1	24	4	0	1	100	131	147	37	48	12	4
2	8	0	1	4	4	3	185	22	6	8	0	3	2
3	12	10	27	3	0	12	5	4	5	7	1	1	3
4	12	8	10	5	4	35	136	14	16	5	0	1	2
5	9	11	22	7	9	5	14	14	36	1	26	1	6
6	17	16	6	1	49	3	54	77	68	11	5	0	1
7	6	7	1	1	1	0	0	2	60	1	1	0	1
8	7	21	1	2	2	2	4	0	2	0	1	3	3
9	13	11	1	0	0	0	0	28	35	4	25	1	0
10	8	6	8	2	4	5	2	3	0	0	0	0	1
11	13	9	46	4	18	77	51	54	24	16	27	1	0
12	5	1	0	0	0	1	3	18	7	1	22	2	2

1/ The beginning of period 6 coincided with sunset.
2/ Sunrise occurred approximately in the middle of period 11.

Appendix Table 23: Numbers of eggs laid by caged Psorophora columbiae per 2 h over a 24 h period beginning August 12, 1983.

Cage Number	Mosquitoes/ Cage	Time Period											
		1	2	3	4	5	6 1/	7	8	9	10	11 2/	12
1	16	48	23	9	62	28	108	58	13	47	29	18	18
2	14	2	1	3	6	44	28	31	26	27	10	2	3
3	9	1	0	0	0	14	25	13	3	0	0	1	2
4	12	13	20	16	9	18	5	5	6	4	7	3	1
5	10	16	19	1	2	3	17	6	2	3	2	0	1
6	9	14	1	0	0	0	0	0	0	2	0	0	1
7	10	0	1	1	0	15	23	35	19	3	20	12	7
8	11	14	0	13	5	4	4	4	0	10	5	5	2
9	14	2	3	1	3	5	3	1	5	5	2	1	0
10	13	9	13	5	2	1	95	27	7	4	1	1	2
11	9	2	5	0	4	3	3	1	1	0	0	0	0
12	13	11	0	1	2	5	36	42	8	14	41	25	7

1/ The beginning of period 6 coincided with sunset.
2/ Sunrise occurred approximately in the middle of period 11.

Appendix Table 24: Analysis of variance procedure for transformed[1/] data from 24 h observations of oviposition by caged *Psorophora columbiae*.

Source	df	Sum of squares	Mean squares	F value	PR>F
time period	11	579.3366	52.6670	9.55	0.0001
date	2	118.6739	59.3370	10.76	0.0001
time x date	22	153.0405	6.9564	1.26	0.1935
error	384	2117.8544	5.5152		

[1/] Data was transformed by taking the square root.

Appendix Table 25: Numbers of eggs laid at various soil moisture levels by caged *Psorophora columbiae* during a test beginning October 1, 1983.

Cage Number	% Moisture beginning	% Moisture ending	Number of eggs
1	0	2.8	2
	20	15.8	95
	40	35.6	29
	60	58.6	100
	80	74.8	18
	100	100.0	17
2	0	3.0	0
	20	20.0	3
	40	34.6	203
	60	54.2	17
	80	73.4	4
	100	100.0	98
3	0	3.8	1
	20	18.2	12
	40	35.8	52
	60	55.4	8
	80	75.8	13
	100	100.0	0

Appendix Table 26: Numbers of eggs laid at various soil moisture levels by caged *Psorophora columbiae* during a test beginning October 2, 1983.

Cage Number	% Moisture beginning	% Moisture ending	Number of eggs
1	0	3.6	3
	20	16.4	6
	40	36.4	201
	60	56.6	22
	80	77.0	63
	100	100.0	39
2	0	3.0	0
	20	14.2	72
	40	34.8	194
	60	55.4	67
	80	71.8	5
	100	100.0	224
3	0	3.8	9
	20	17.0	13
	40	36.6	24
	60	57.8	20
	80	77.0	12
	100	100.0	7

Appendix Table 27: Numbers of eggs laid at various soil moisture levels by caged *Psorphora columbiae* during a test beginning October 3, 1983.

Cage Number	% Moisture beginning	% Moisture ending	Number of eggs
1	0	3.6	2
	20	17.2	47
	40	36.6	0
	60	57.8	15
	80	77.2	8
	100	100.0	3
2	0	2.4	1
	20	15.4	3
	40	35.8	6
	60	55.8	2
	80	75.0	1
	100	100.0	1
3	0	4.0	2
	20	17.8	21
	40	37.6	99
	60	57.2	4
	80	76.8	2
	100	100.0	0

Appendix Table 28: Numbers of eggs laid at various soil moisture levels by caged *Psorophora columbiae* during a test beginning October 10, 1983.

Cage Number	% Moisture beginning	% Moisture ending	Number of eggs
1	30	27.6	303
	40	36.8	577
	50	46.8	540
	60	56.4	117
	70	66.6	34
	80	77.2	14
2	30	26.8	86
	40	36.6	34
	50	47.4	237
	60	56.6	12
	70	66.4	69
	80	75.8	4
3	30	29.4	236
	40	37.6	341
	50	47.6	268
	60	57.2	61
	70	66.8	84
	80	75.2	134
4	30	28.0	171
	40	38.0	218
	50	47.0	78
	60	56.2	23
	70	67.2	8
	80	74.6	39

Appendix Table 29: Numbers of eggs laid at various soil moisture levels by caged *Psorophora columbiae* during a test beginning October 11, 1983.

Cage Number	% Moisture beginning	% Moisture ending	Number of eggs
1	30	26.8	111
	40	35.6	232
	50	46.2	58
	60	56.0	13
	70	65.6	5
	80	73.6	11
2	30	25.6	3
	40	34.8	19
	50	45.8	20
	60	54.4	45
	70	64.8	124
	80	76.4	10
3	30	26.0	18
	40	36.0	60
	50	45.2	73
	60	56.0	8
	70	65.6	22
	80	74.6	39
4	30	25.6	78
	40	36.2	28
	50	47.6	141
	60	56.8	38
	70	65.2	24
	80	75.2	1

Appendix Table 30: Analysis of variance procedure for numbers of eggs laid by caged _Psorophora columbiae_ at soil moisture levels ranging from 0% to 100%. Baton Rouge, LA, 1983.[1/]

Source	df	Sum of squares	Mean squares	F value	PR>F
moisture level	5	37.9004	7.5801	3.99	0.0042
linear	1	2.0924	2.0920	1.10	0.2992
quadratic	1	23.8685	23.8685	12.57	0.0009
cubic	1	11.0869	11.0869	5.84	0.0196
quartic	1	0.4013	0.4013	0.21	0.6478
error	48	91.1790	1.8996		

[1/] Data were transformed by adding 1 to each number and then taking the natural logarithm of the resulting number.

Appendia Table 31. Analysis of variance procedure for numbers of eggs laid by caged _Psorophora columbiae_ at soil moisture levels ranging from 30% to 80%. Baton Rouge, LA, 1983.[1/]

Source	df	Sum of squares	Mean squares	F value	PR>F
moisture level	5	25.5784	5.1157	3.65	0.0079
linear	1	17.9583	17.9583	12.80	0.0009
quadratic	1	2.7308	2.7308	1.95	0.1703
cubic	1	1.8695	1.8695	1.33	0.2549
quartic	1	0.2119	0.2119	0.15	0.6995
error	42	58.9260	1.4030		

[1/] Data were transformed by adding 1 to each number and then taking the natural logarithm of the resulting number.

VITA

Dwight Charles Williams is the son of Francis and Betty Williams. He was born in Stuttgart, Arkansas on October 3, 1955. He grew up near Stuttgart on the University of Arkansas Rice Research and Extension Center where his father is center director. He graduated from Stuttgart High School in 1973. He attended the University of Arkansas at Fayetteville and received a Bachelor of Science degree in Agriculture in 1977. Subsequently he entered graduate school at the University of Arkansas and received a Master of Science degree in Entomology in 1979. He is married to the former Susan Elizabeth Millar also of Stuttgart. Currently he is a candidate for the Doctor of Philosophy degree at Louisiana State University at Baton Rouge.

EXAMINATION AND THESIS REPORT

Candidate: Dwight Charles Williams

Major Field: Entomology

Title of Thesis: Oviposition of Psorophora columbiae (Dyar and Knab) in Louisiana Pastureland

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Vernon Lee Wright

Date of Examination:

July 5, 1984